

Exercise 15

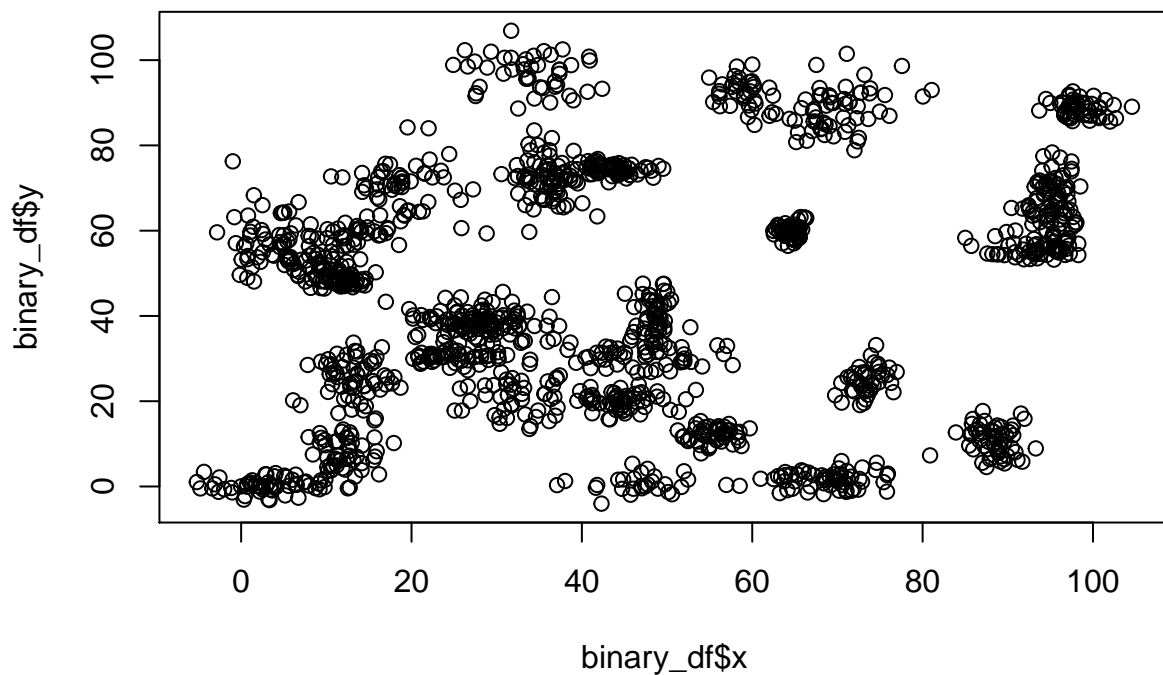
Thip Rattanaivilay

2/12/2021

Introduction to Machine Learning

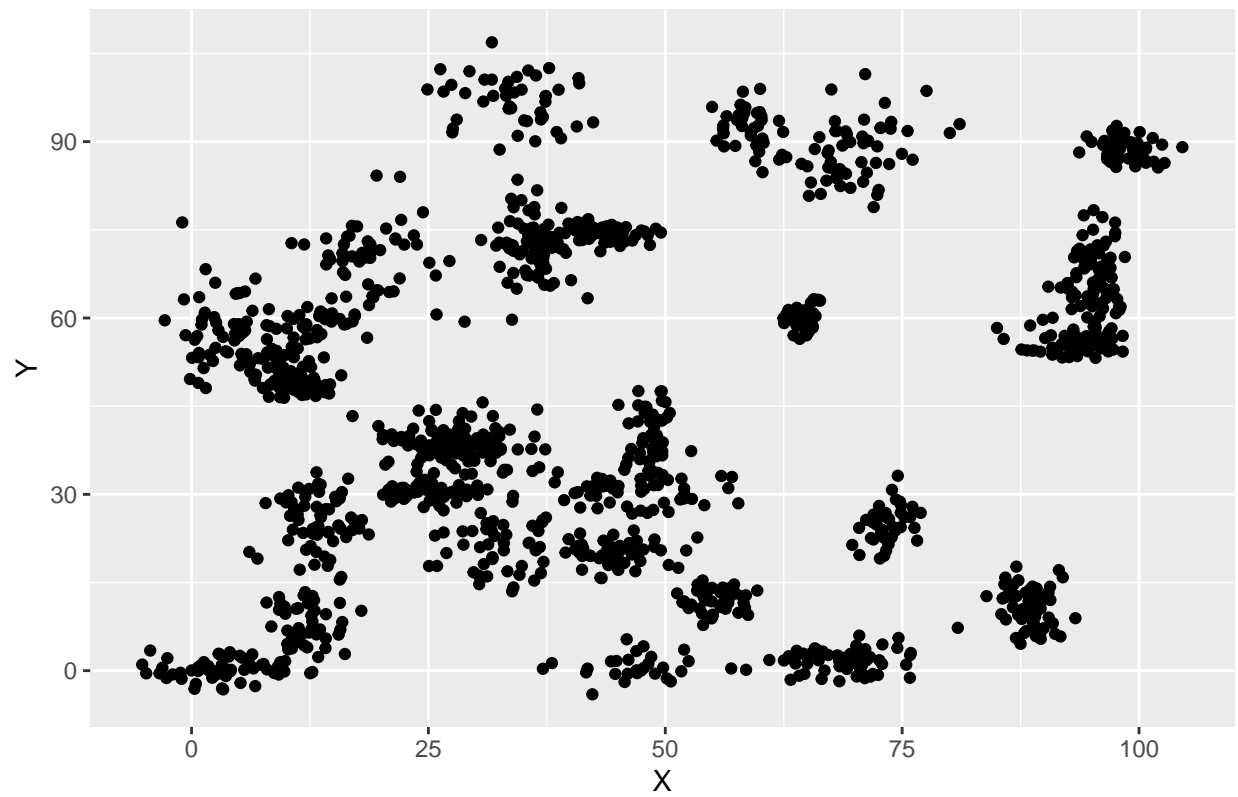
A. Plot the data from each dataset using a scatter plot

```
plot(binary_df$x, binary_df$y)
```

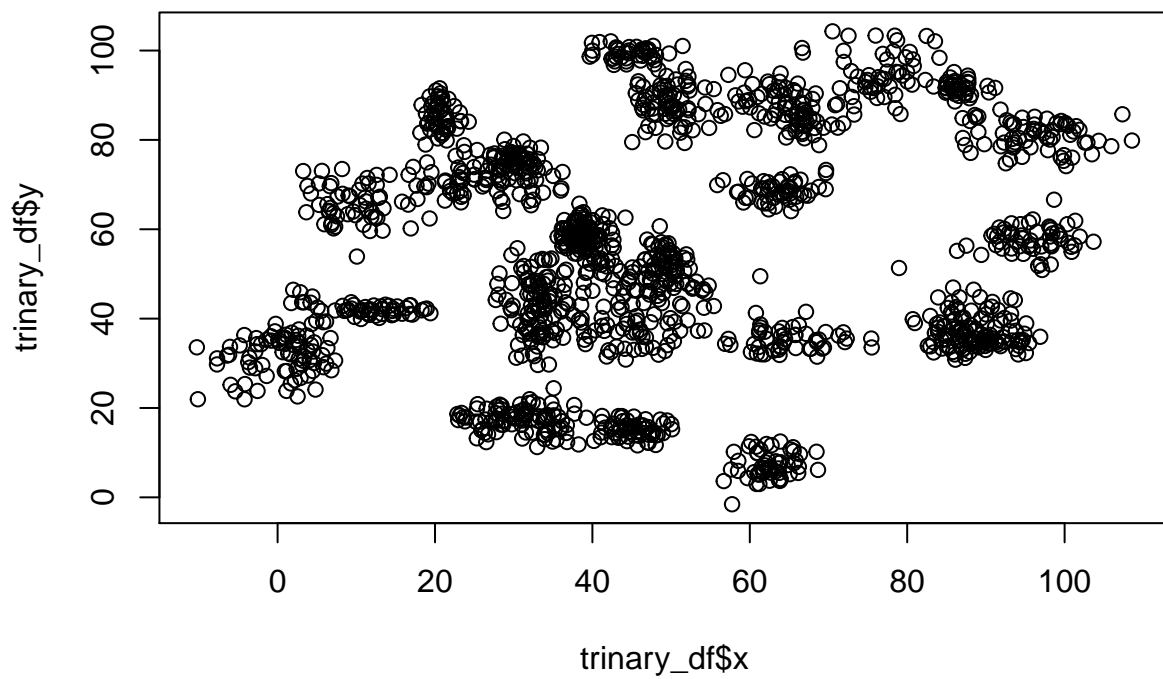


```
ggplot( binary_df, aes(x= x, y= y)) + geom_point( ) +  
  labs(title= "X vs Y", x="X", y="Y")
```

X vs Y

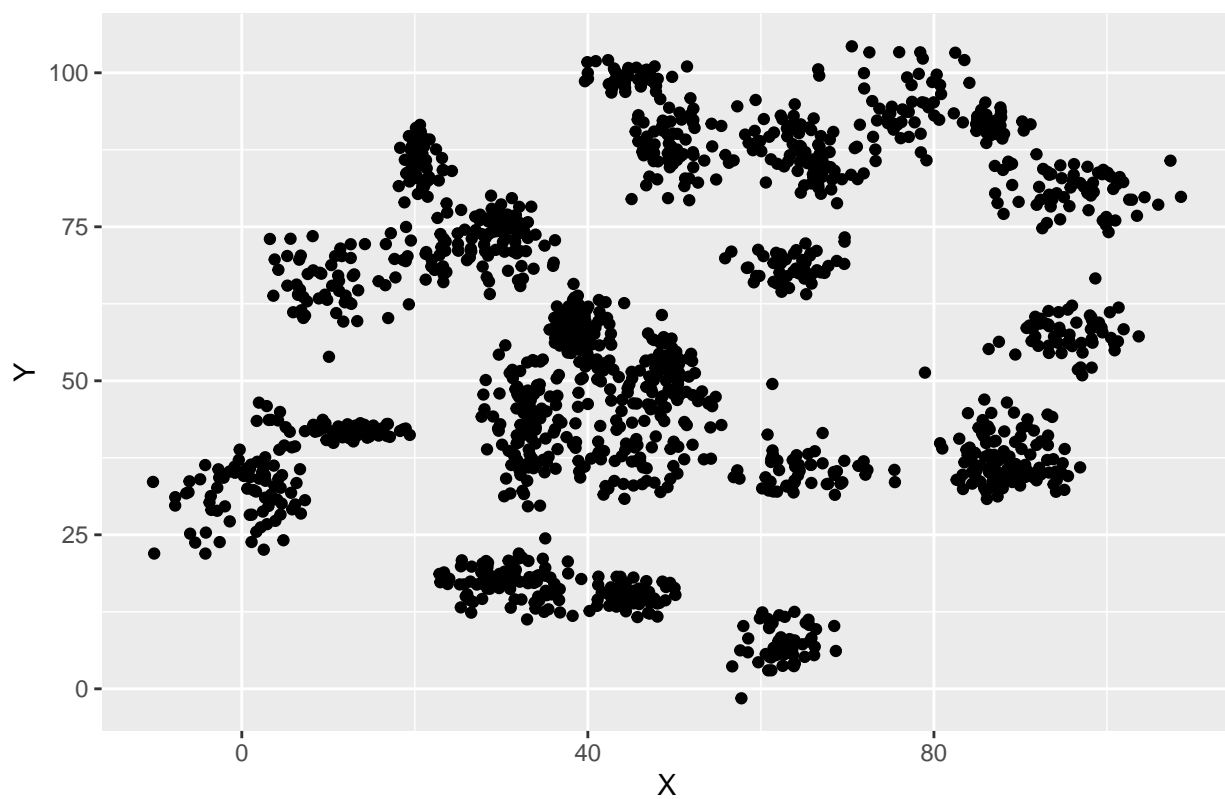


```
plot(trinary_df$x, trinary_df$y)
```



```
ggplot( trinary_df, aes(x= x, y= y)) + geom_point( ) +  
  labs(title= "X vs Y", x="X", y="Y")
```

X vs Y



B. The k nearest neighbors algorithm categorizes an input value by looking at the labels for the k nearest points and assigning a

category based on the most common label. In this problem, you will determine which points are nearest by calculating the Euclidean

distance between two points. As a refresher, the Euclidean distance between two points:

and

is

The k nearest neighbors algorithm categorizes an input value by looking at the labels for the k nearest points and assigning a

category based on the most common label. In this problem, you will determine which points are nearest by calculating the Euclidean

distance between two points. As a refresher, the Euclidean distance between two points:

```
normalize <-function(x) { (x -min(x))/(max(x)-min(x))  }  
binary_norm <- as.data.frame(lapply(binary_df[,c(2:3)],normalize))  
head(binary_norm)
```

```
##           x           y  
## 1 0.6930933 0.7861557  
## 2 0.7303243 0.8290011  
## 3 0.7194983 0.8675355  
## 4 0.6523084 0.7674851  
## 5 0.6765989 0.7984207  
## 6 0.7054045 0.8150698
```

```
data_split <- sample(1:nrow(binary_norm), .8 * nrow(binary_norm))  
train<- binary_norm[data_split,]  
head(train)
```

```
##           x           y  
## 638 0.1402959 0.2361897  
## 431 0.1919833 0.3101486  
## 1227 0.5585808 0.1586645  
## 358 0.1320439 0.4700906
```

```
## 306 0.4484554 0.2161808
## 1072 0.6407264 0.5559078
```

```
dim(train)
```

```
## [1] 1198 2
```

```
test<- binary_norm[-data_split,]
```

```
target_category<-binary_df[data_split, 2]
```

```
test_category<- binary_df[-data_split, 2]
```

```
target_category
```

```
## [1] 10.200662118 15.874706190 56.118415035 9.294790888 44.029259677
## [6] 65.136040967 97.903510959 95.527703666 37.390068231 11.218038249
## [11] 96.004871958 32.149759785 47.687614181 71.709356056 32.363638857
## [16] 92.985399375 40.923401908 70.925135193 49.002572608 6.389315251
## [21] 97.473038843 13.616695096 5.787933624 45.055788024 101.561101688
## [26] 24.807424993 15.646961817 10.995035441 12.175400121 47.162205637
## [31] 53.386184291 34.816792846 97.588682597 0.723871963 29.518231035
## [36] 38.660504935 42.110562278 70.475354921 33.295475854 60.171788654
## [41] 67.527688260 7.955788458 4.536617625 90.901992170 46.511304881
## [46] 49.225355242 76.582582005 64.049628770 58.276616472 94.554581086
## [51] 23.738698558 9.630278514 39.514866433 24.428917131 72.903439485
## [56] 72.702600399 31.738680231 87.247501175 25.335350553 73.898948845
## [61] 29.432167427 7.038285079 88.936393036 -1.049711299 37.939969972
## [66] 4.049300327 93.401927840 29.040979670 -0.626121742 68.410285087
## [71] 1.399888028 44.457783977 91.343652157 72.826593267 37.146759535
## [76] 31.555668404 30.723296648 12.614737626 46.971861040 4.873908658
## [81] 48.382021745 36.864751293 38.814797999 56.721950146 47.447758197
## [86] 26.635568386 66.340775837 12.349013099 97.979749801 21.416015490
## [91] 26.136127238 40.961792439 70.398545156 41.172960215 94.802504564
## [96] 19.533754999 62.542863636 14.501814030 11.373373376 13.661909845
## [101] 3.219510996 9.795702140 71.413610465 51.595518698 68.155758405
## [106] 24.217560815 98.282925052 97.558320440 45.062284642 93.254032837
## [111] 44.333522296 56.133214428 47.146643543 47.896460648 93.472693670
## [116] 2.184794635 48.725884427 87.070488760 40.901355806 12.111349643
## [121] 99.612834536 40.565872292 35.895960096 63.231838105 21.180042064
## [126] 71.051919757 54.124146695 67.246225819 20.200275564 33.624863178
## [131] 9.345831490 96.697952992 28.699259119 65.415711826 22.411321604
## [136] 34.057638500 96.198066843 72.521797778 11.395345753 95.221427140
## [141] 96.653153990 9.388699054 96.954331281 32.073612499 33.470462689
## [146] 30.852420755 63.387494435 96.900718534 2.927273247 74.617081791
## [151] 43.152317265 2.533514308 39.471712826 73.846898471 22.005164071
## [156] 60.008253114 46.474867901 15.805117422 36.834339694 50.022143358
## [161] 11.200686275 44.552515990 57.261140889 94.429063518 90.447769801
## [166] 42.025137396 5.263150408 88.336004682 25.589061144 52.215307328
## [171] 90.158365229 28.226936577 63.467484512 8.221066512 35.925834482
## [176] 21.057199244 7.817087308 94.066737667 92.940506451 -4.781815410
## [181] 0.744330030 56.164020653 49.682167239 6.748676742 1.056347060
## [186] 90.850068539 23.976754780 35.086584057 51.985373643 54.362119242
## [191] 8.329654099 97.276970593 32.518557953 70.496254383 45.961257943
```

##	[196]	54.139728136	95.084372807	37.858142854	96.027176688	80.875352021
##	[201]	46.676195074	23.038279883	34.953129776	68.694956978	95.095115743
##	[206]	36.613131106	50.273841315	59.039483779	47.002127091	5.068635941
##	[211]	64.044533798	71.656258542	6.702547834	41.953329409	26.586510050
##	[216]	88.024357311	33.995046958	20.449799908	69.073994657	13.463288969
##	[221]	22.668532848	47.389712393	66.631764045	33.974312587	57.161282894
##	[226]	58.745527581	89.021746392	97.154833918	96.492292607	36.223288202
##	[231]	53.912753960	35.232295568	26.843645666	36.488001653	57.045302229
##	[236]	96.078054446	95.415812154	45.928742756	44.338971789	48.299248604
##	[241]	57.752358783	10.779380988	33.918246520	47.734754226	41.162469321
##	[246]	13.606944882	58.127825458	54.931742509	102.435607932	44.267995222
##	[251]	23.737671025	35.401847086	12.958824363	65.161240473	58.510076261
##	[256]	29.526724896	64.186350066	96.761371278	29.264796903	53.626288575
##	[261]	93.692390665	3.198811727	12.406202099	41.783336855	47.328235419
##	[266]	37.821079829	47.404369411	37.227599814	11.540024012	72.376287805
##	[271]	13.179170548	96.751142916	56.506374698	52.465904128	39.424699479
##	[276]	29.335288765	26.363536069	2.263850975	67.951244261	29.666495223
##	[281]	-1.991629484	88.670222783	31.308812813	10.498699814	49.621587974
##	[286]	27.583199044	43.718994827	35.873817784	71.101166845	36.881862706
##	[291]	35.893405214	1.279627592	102.004511873	12.198067866	28.223552077
##	[296]	27.027676599	86.256250080	68.553538889	6.532928543	14.782075115
##	[301]	-0.802080463	100.721176750	96.278227927	74.248124908	13.623003083
##	[306]	66.407470498	73.342543627	28.902514041	96.280483868	60.266280654
##	[311]	67.139472138	58.349554211	40.654978139	31.984965378	37.087332990
##	[316]	73.165316376	27.434560561	70.796696620	58.453284457	41.732913900
##	[321]	44.081930679	12.740100053	77.574540432	88.405829718	90.856409687
##	[326]	12.274009603	25.573250285	49.057638960	43.482044408	43.346588203
##	[331]	21.110294310	39.800202343	45.199257397	30.122301011	33.253355209
##	[336]	95.764736592	65.172480839	47.699815148	52.015871301	97.110720647
##	[341]	85.773197601	64.476025837	56.372204220	36.728557024	35.390845113
##	[346]	45.535699455	17.244666802	11.210568223	6.153718860	15.935459948
##	[351]	28.738840853	14.830302801	63.062339881	14.377386870	13.590644494
##	[356]	48.155473548	5.563065639	35.460576519	31.757281571	91.833358559
##	[361]	46.130589454	25.930717929	66.261353495	47.477059656	64.371898705
##	[366]	59.970595469	31.201115292	45.199291962	-5.200496182	89.845419021
##	[371]	59.043290929	9.229828367	89.154732960	8.736464357	45.653517283
##	[376]	71.407892930	44.768845483	25.785995880	63.226239805	49.144735580
##	[381]	31.391073881	88.363277829	11.986458904	40.925696762	28.722372021
##	[386]	55.840000820	70.207051313	63.871532043	58.084976344	94.225742455
##	[391]	87.275323281	26.598914424	3.631547198	41.872817066	49.534415851
##	[396]	47.796494889	73.309710555	89.310653505	9.975405518	22.217195632
##	[401]	3.845265269	55.833763327	91.707785822	97.235812115	48.401257658
##	[406]	37.005947757	69.160437175	6.428534072	49.053408211	15.157780125
##	[411]	60.146153899	15.659788452	59.782748705	12.398066620	24.240472829
##	[416]	10.579758528	9.234196171	97.177935005	64.900737195	43.004952168
##	[421]	96.665029554	56.369858047	98.510648728	98.445018110	1.298305237
##	[426]	0.708282895	9.615365267	8.721650166	42.093318838	100.751090232
##	[431]	13.256908702	69.733179363	70.328466371	32.961538625	75.919779906
##	[436]	23.863110085	49.861183855	48.263287921	6.652554889	93.712458371
##	[441]	66.136045101	38.981119864	63.544329666	2.550707139	96.622825742
##	[446]	30.799802023	32.648881030	34.858769685	34.425154956	9.881853629
##	[451]	40.059094769	47.673405671	96.989491021	48.205285630	12.903526569
##	[456]	20.777625589	36.178193603	7.993121425	31.564295973	51.957878078
##	[461]	29.024162467	96.682589102	4.599363143	51.249127278	10.554285197

##	[466]	94.582287559	14.029737880	88.496091902	16.217635257	24.248186670
##	[471]	87.740174000	97.099995345	97.416418430	88.432318129	26.162742126
##	[476]	94.048842596	2.845202010	69.168651230	44.873221034	33.937711176
##	[481]	10.625257337	97.655995133	46.889547079	30.159514128	83.908097822
##	[486]	19.099688339	22.663143177	44.114215911	92.150164086	87.631489923
##	[491]	10.117039441	97.186349072	67.905321976	73.566736391	7.580919833
##	[496]	16.940819103	11.934858361	97.918467457	71.194441620	34.407744012
##	[501]	10.736079917	45.883525571	0.808451642	3.336736626	36.164555199
##	[506]	41.008953501	95.208369458	49.229161435	23.464836532	26.733931793
##	[511]	22.414617614	11.669984512	91.958670835	33.435780949	86.689653028
##	[516]	43.022963352	41.298517670	62.023651069	56.064332228	11.007960135
##	[521]	14.766091661	15.632397858	11.575181183	44.413558290	46.845819671
##	[526]	12.981959162	28.817182141	68.165837095	97.669641573	65.100641340
##	[531]	51.376641358	7.537792702	31.766420820	1.247836449	24.505701278
##	[536]	89.195835488	39.787982976	26.906237142	64.603657776	10.692399388
##	[541]	67.473153040	68.017091794	76.302803978	45.031631099	28.186544341
##	[546]	72.562691600	26.819925599	37.331293157	30.783718646	5.109270565
##	[551]	32.477421211	13.161167081	36.876360479	25.916409623	27.376230207
##	[556]	96.819698514	27.471322382	88.330108477	88.093528424	-3.381874674
##	[561]	37.086799225	72.920966451	93.384230094	88.352280552	67.208283103
##	[566]	48.743382685	41.330070403	23.394391206	21.341408085	51.992988082
##	[571]	11.288127043	92.627746882	37.087321669	55.941764840	44.707617440
##	[576]	72.880164929	87.497299688	61.999684982	6.410981008	27.277736119
##	[581]	40.739344213	59.708038997	86.496747628	10.599292969	11.048931602
##	[586]	-2.825958500	44.138331275	57.725948753	40.761325975	12.527526373
##	[591]	48.519278490	10.395807743	0.056642086	28.574134171	60.383547370
##	[596]	48.914742015	47.492681412	92.891406651	97.380941079	64.903447104
##	[601]	71.567593513	-3.072394086	33.963129456	17.472225991	25.079298047
##	[606]	25.860523842	41.649987997	36.145212433	35.629924538	49.252810927
##	[611]	94.258174997	59.505714887	56.199150998	97.896059408	73.068875388
##	[616]	59.347434455	35.544451819	10.885156322	56.636411945	90.887312233
##	[621]	25.099720641	9.181423461	48.674940112	10.823970837	33.961800440
##	[626]	93.467168469	65.668715505	29.634151453	72.756236407	36.527503062
##	[631]	94.955556075	47.163142153	95.386781813	33.824830304	74.851072920
##	[636]	25.340355227	5.041892216	71.618549861	43.778405875	94.908451167
##	[641]	29.851248918	17.985239511	63.789115929	95.664682897	17.215832874
##	[646]	9.197870399	28.219478262	35.667400650	73.173629782	5.548768188
##	[651]	10.111395315	93.846748111	48.861966094	36.203780665	65.427260819
##	[656]	92.450275533	17.968932762	21.968666648	54.148132945	90.471918439
##	[661]	44.308645454	93.806389355	19.188521485	96.094753660	43.155435941
##	[666]	48.786141185	43.347998016	8.309003610	95.341631466	42.703095372
##	[671]	33.000924641	15.281465978	12.774823090	13.699367738	18.372060266
##	[676]	10.560398820	8.422408040	71.907770202	8.163189935	41.504925690
##	[681]	66.810804185	35.905068075	60.254860323	0.598018117	28.822365131
##	[686]	16.188923010	11.888798441	47.774312598	16.930011500	32.144013148
##	[691]	12.761357852	47.370825101	48.638690108	9.726951072	65.610631020
##	[696]	97.253672335	15.800348168	43.722726553	93.377050902	89.929231347
##	[701]	13.556229189	90.092097056	44.615439055	67.193133404	65.030210923
##	[706]	38.997386799	59.910637497	63.024822085	92.452281835	12.503099508
##	[711]	55.008461140	14.614588096	14.171927510	11.754786804	36.351242528
##	[716]	32.105721491	4.984163906	73.768595992	6.206436911	22.842255607
##	[721]	54.885249852	48.874239495	85.607412717	14.200838426	46.199076521
##	[726]	35.394358044	25.518871284	48.403230927	23.431644406	42.352602950
##	[731]	29.573266401	28.874755260	98.060431514	37.130410639	75.578148088

##	[736]	34.612836739	18.808370900	37.406996852	11.568511003	9.766212604
##	[741]	18.854079713	22.968255625	41.636132046	76.106788991	42.384607578
##	[746]	38.330379632	25.142003613	33.590812198	48.734620071	4.661916116
##	[751]	1.728849036	71.280803989	65.077559014	98.742962955	87.008971885
##	[756]	12.117217197	19.533518108	97.693269332	5.778474130	86.694102754
##	[761]	8.161310967	63.140396007	69.521713484	95.602888840	9.364323523
##	[766]	94.602474977	34.435615695	70.588681841	9.923369605	12.089668655
##	[771]	67.541851122	71.040231553	21.326195084	70.981231268	44.609054376
##	[776]	16.087608460	30.446088608	85.467953281	97.457499524	11.381509799
##	[781]	0.335797013	56.960628931	18.532793355	35.993595792	33.880582938
##	[786]	13.964016463	44.520450090	36.830586042	58.525917434	59.609037515
##	[791]	20.176107125	92.923445507	57.569515334	38.051940747	20.218275936
##	[796]	30.360789762	31.803259915	48.836295513	33.735366587	98.899222615
##	[801]	88.748304027	38.630367083	12.570839822	49.039123720	96.347009436
##	[806]	16.987550661	0.457352695	63.738890695	73.441849635	74.340547362
##	[811]	28.977680934	5.658337207	11.779633555	33.094437768	65.372787218
##	[816]	100.224343150	11.896678127	16.311997888	31.672179985	1.512351702
##	[821]	18.902697309	34.322690882	14.183378989	46.516810617	64.892641369
##	[826]	89.802604901	95.780065572	16.321281042	66.041600472	44.971851604
##	[831]	12.746873224	7.920728463	16.421331016	12.453444566	32.901317158
##	[836]	64.987671487	11.268813016	59.680729907	9.119811695	32.961253130
##	[841]	72.776458767	9.976940493	44.944212144	25.104890906	14.311285172
##	[846]	25.886734919	28.861709595	13.971128866	23.844800213	36.698970499
##	[851]	9.807524696	26.493992804	11.130592646	53.361105063	12.648359187
##	[856]	85.791897449	1.906849312	45.677902766	90.704894922	68.403771555
##	[861]	31.230184413	12.006713156	6.723862419	71.997459723	48.483907267
##	[866]	68.375153732	91.134536609	5.825513990	74.492889642	45.046372614
##	[871]	76.081201484	65.456899257	27.430057660	25.869287995	43.991315267
##	[876]	65.377351403	8.775964474	65.780054972	16.367057654	99.201448228
##	[881]	95.412791602	41.215133789	22.687571376	49.643049611	23.762672750
##	[886]	22.340076321	10.457567245	2.059719950	57.707883662	57.940940744
##	[891]	38.238573619	11.889142808	48.834130524	43.275995031	33.259607280
##	[896]	11.921135828	38.038163142	63.877933394	19.696705547	54.937833983
##	[901]	18.599675684	28.417574777	35.590842994	69.714915575	97.495458480
##	[906]	16.100274480	25.085657394	43.322019691	1.490995382	37.739718368
##	[911]	45.432576304	100.732761692	50.472839180	49.546307347	26.599722635
##	[916]	28.074851394	50.155714086	4.086314425	66.157651289	46.686923633
##	[921]	11.421372357	11.974804092	45.487674861	31.697807312	49.518665134
##	[926]	89.614594815	42.058328298	51.691416541	63.840372560	49.711177692
##	[931]	64.827960992	14.140655772	34.839538593	65.564226322	68.494245276
##	[936]	50.348455549	81.065592562	36.481692766	33.359809399	46.405449729
##	[941]	34.437286724	96.995187410	36.579348833	15.914058401	73.103152510
##	[946]	64.997270200	18.643613787	12.789238258	27.457700978	56.476353204
##	[951]	4.165583236	21.129169217	56.098771765	52.464158703	28.990369252
##	[956]	-0.980014497	33.219682648	46.957491110	71.921007676	3.919976275
##	[961]	97.481568610	47.099390226	99.852586152	44.919865738	2.390423787
##	[966]	18.907891490	14.102187155	72.374338529	68.601449383	56.850620989
##	[971]	98.805764842	9.168418735	62.438871648	11.759362165	72.652766036
##	[976]	22.145058912	69.549823144	53.994800799	62.740740078	58.410329543
##	[981]	9.891174652	12.054046190	41.179166105	22.127387062	76.956172430
##	[986]	55.913849600	69.096336185	97.745617819	8.942328543	45.713738173
##	[991]	87.889374168	37.354986758	20.817986624	70.154290314	7.957889730
##	[996]	74.544734559	64.189156809	64.236626266	3.848261674	56.654104765
##	[1001]	71.985037292	29.981688629	49.674285280	44.200475171	101.449074850

##	[1006]	28.369630616	30.524703941	72.441986262	90.642321903	33.608038852
##	[1011]	56.088330508	64.876078121	30.330439192	31.987534927	13.369923684
##	[1016]	2.858491323	43.577761798	70.884690968	37.409545854	95.141678969
##	[1021]	43.278807546	97.632897192	96.360570759	42.106121644	53.887699820
##	[1026]	40.505562133	97.319561728	29.182885173	63.872911097	25.372101837
##	[1031]	42.476166686	92.508759769	95.936898444	13.465555539	41.758762510
##	[1036]	39.229260084	30.740853834	40.437775893	22.383929789	64.862559296
##	[1041]	42.121637387	100.675400046	35.576498641	9.909362015	30.226680157
##	[1046]	4.475035280	19.723599867	8.971405592	24.988692572	27.919150584
##	[1051]	47.586881270	9.899573837	49.657516284	53.940244845	18.879641532
##	[1056]	49.737899456	56.653649991	4.870565440	97.179040841	24.271470851
##	[1061]	69.544184783	45.682254623	37.147169807	41.760450122	90.424975613
##	[1066]	5.084701857	13.207439090	74.769750171	89.589128025	65.371376946
##	[1071]	13.461701356	33.567675881	22.078224987	1.763855402	90.611250329
##	[1076]	5.173509501	75.854890713	64.934637155	54.372765216	-0.161249348
##	[1081]	50.172052537	42.807186142	98.059956917	48.217741834	33.546275786
##	[1086]	69.540365110	93.285473414	36.090601188	12.003395566	46.080816008
##	[1091]	36.611997279	46.096509291	91.541138127	43.842156772	95.429405866
##	[1096]	11.263664391	74.889733132	28.617243647	36.214352938	49.099910501
##	[1101]	5.553038688	14.940250429	27.965894670	47.319592278	52.733075973
##	[1106]	17.921718855	96.497044263	32.853454699	29.322811899	26.371562849
##	[1111]	33.202854211	66.505536814	53.414442454	25.479550693	31.123587911
##	[1116]	30.919527091	14.650509130	42.298889605	94.148995885	-0.001494431
##	[1121]	33.833335226	5.322096891	64.691437119	55.416979527	11.308509028
##	[1126]	22.452793765	75.246589815	87.595156448	58.110362840	22.489315957
##	[1131]	91.895892202	41.026345541	40.663859748	93.052076465	25.065299502
##	[1136]	71.961313219	16.669075258	65.779942637	94.956209388	62.770504824
##	[1141]	12.466901903	48.672013702	15.713390385	54.978465740	17.708801861
##	[1146]	70.170051265	10.314218260	69.944531000	95.385506379	28.620042405
##	[1151]	9.058022785	72.592305370	32.487559941	94.610791211	10.829684019
##	[1156]	98.275077805	38.537629208	30.561385796	36.829133498	71.105041304
##	[1161]	6.798675384	94.987639914	17.148495855	27.811669545	24.898159964
##	[1166]	11.239628912	9.822310902	15.742125755	95.961554136	97.751757796
##	[1171]	12.843746972	96.001311382	13.234022678	88.930696452	43.539213681
##	[1176]	2.588505036	57.392332560	12.042084960	37.039043543	80.034574431
##	[1181]	95.928781221	27.224606709	3.320606790	57.405816024	68.093818194
##	[1186]	69.036600706	100.074922317	93.242277463	71.225362304	5.413157939
##	[1191]	96.534075656	96.143440034	47.836372249	58.195487270	51.988036371
##	[1196]	97.336588300	37.224332497	93.075959883		

test_category

##	[1]	74.9717632	73.7833288	72.2361604	70.7026045	69.2368027	73.6270391
##	[7]	67.0106498	49.2039681	48.7402825	48.6798937	48.0075286	48.1391333
##	[13]	41.2294005	44.1967187	43.3426943	45.2309812	41.1007881	44.7032133
##	[19]	43.1026130	43.5945111	45.8420743	44.5846709	41.2428102	43.7604865
##	[25]	41.7718827	91.7386664	93.2974802	88.5138761	96.2046727	97.9234114
##	[31]	94.5422785	94.8743299	92.5404399	95.8467731	10.1359686	13.2437116
##	[37]	12.4749126	18.7265627	10.0663465	12.2225454	16.9989221	16.2392496
##	[43]	59.0298634	62.3317666	44.5718001	50.3683735	44.8617982	36.3321393
##	[49]	41.2442396	43.8210871	43.9155758	44.8674736	3.6201506	13.7749774
##	[55]	8.4700131	12.3842935	10.7722090	0.7845488	10.4581540	9.0886024
##	[61]	8.0634601	11.4906606	10.7992356	9.4377236	88.5894634	89.1376604
##	[67]	87.0581844	86.7326577	89.6254183	88.7634305	89.1200163	88.8099496

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## [73] 85.9518915 85.8917399 24.0132344 15.6455787 25.4089319 24.7668077
## [79] 27.5369980 22.1805023 16.5277315 22.1641785 30.1714300 25.8625359
## [85] 3.4553199 7.4028730 2.2546157 3.5232668 1.0212582 6.0195747
## [91] 3.8926730 -1.1640574 2.9624154 -2.5494194 -2.6456544 -4.3603692
## [97] 0.6915510 0.3129262 7.5935756 95.2063769 93.4594869 93.1485788
## [103] 95.7006791 94.6629051 94.4902863 95.1477062 94.1719860 95.7757372
## [109] 93.7482798 31.8356401 36.7638021 25.6871266 31.1469638 33.3408519
## [115] 35.9860425 26.6077840 29.7631491 39.3217119 17.7057623 6.1013391
## [121] 12.7958799 15.5080031 10.8323156 14.4479575 13.1902629 13.3637487
## [127] 14.4404858 13.1100469 13.3895407 16.9717194 12.0035253 6.9599209
## [133] 18.7081522 9.3652175 10.2270103 14.6357352 16.8371284 2.5017758
## [139] 5.6391706 5.4160144 1.0953127 98.8270573 94.4824344 99.3744402
## [145] 99.5840819 99.3202350 102.6993636 96.9419832 99.7041284 96.4136435
## [151] 98.0842275 104.5757555 19.9046377 15.9259423 21.5149823 20.5320278
## [157] 23.7903604 14.4339416 21.5356144 14.2211110 15.9912459 20.8625998
## [163] 25.7789953 18.0108724 48.1176871 52.0367184 47.4558002 42.8519670
## [169] 45.6874931 51.7852550 47.4712733 51.7102628 52.8110929 32.4535992
## [175] 27.8883881 27.8247421 26.8641761 25.7848707 32.6278652 28.3362487
## [181] 30.5999240 30.9326371 27.2135296 28.8156617 29.3203171 95.2123460
## [187] 93.1090942 96.8349123 89.6029658 93.9816070 96.7927668 88.1937644
## [193] 85.7136852 85.0104416 93.1667664 24.2667539 24.6265285 20.7811472
## [199] 29.2099169 28.1625626 31.9857871 64.1759163 65.8643931 65.5669335
## [205] 64.4536047 62.9934091 65.3884588 64.5606657 65.3875868 63.8417264
## [211] 64.9044908 63.5400360 64.3865972 65.2481391 64.9156716 62.4766913
## [217] 63.7824941 72.2983972 73.9260541 70.4521524 73.2671769 73.6096531
## [223] 74.0186220 74.8480084 38.0327116 49.7686523 44.8446236 46.0365270
## [229] 42.3034648 50.5835335 44.7234009 47.0318863 41.7989292 46.1148737
## [235] 64.1307457 68.6717998 64.5780509 68.3495999 75.8188645 75.8382371
## [241] 66.1876878 62.5192462 65.2864043 60.9853377 70.7776657 75.4281643
## [247] 51.8177242 54.8887254 52.4844882 55.7458813 54.4955981 52.7469474
## [253] 37.6670386 34.6440024 32.5245801 36.4856758 38.6407978 39.0328678
## [259] 37.2354814 36.4024552 41.8073741 12.1025368 14.0989389 12.0633092
## [265] 11.6642665 13.1039693 12.1202463 14.5278925 12.0893452 8.8818069
## [271] 12.7797499 12.3080728 11.8401200 11.2572473 10.6003374 14.1837668
## [277] 12.9817946 15.5261055 12.7062672 12.2175647 12.7539389 12.9300055
## [283] 12.9779946 14.1340255 10.2019654 7.9196535 31.8460831 34.3406231
## [289] 38.7416056 31.6993734 35.5468822 35.1006677 36.2790931 37.3618475
## [295] 27.5256555 33.7426918 28.8857592 40.8481371 27.9966715 26.2598233
```

```
binary3<- knn(train, test,cl=target_category, k=3)
binary3
```

```
## [1] 72.376287804515 72.7026003991885 70.8846909680027
## [4] 68.4102850870777 68.6949569776664 71.2808039892099
## [7] 65.3713769462872 48.4032309268736 48.7433826846658
## [10] 48.7433826846658 47.14664354268 47.8363722494385
## [13] 40.961792439184 43.5777617976381 43.7189948267244
## [16] 44.6090543759643 41.1729602146182 44.4135582895176
## [19] 43.0049521681032 43.0049521681032 44.9442121439931
## [22] 44.3086454540258 40.9013558062896 43.0049521681032
## [25] 41.7604501219249 90.4249756131192 92.9234455069283
## [28] 89.84541902125 95.0843728071748 97.558320440341
## [31] 95.0843728071748 95.3867818130184 92.4502755326176
## [34] 95.0843728071748 8.16318993454417 12.006713156172
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##	[37]	12.0420849595305	17.2158328741169	8.94232854322852
##	[40]	11.3815097991607	16.1002744804252	15.6323978584128
##	[43]	59.0394837787253	59.9106374968867	43.9913152671632
##	[46]	49.5344158507265	44.3335222957169	35.5908429935266
##	[49]	40.9256967620506	43.4820444082376	44.0819306790753
##	[52]	43.9913152671632	2.53351430782321	13.4655555388728
##	[55]	7.9931214246027	11.7593621654487	10.5797585280614
##	[58]	0.0566420864278663	9.16841873469325	8.77596447364277
##	[61]	9.05802278498249	11.5685110029631	9.82231090247629
##	[64]	9.05802278498249	87.6314899225871	88.3632778291166
##	[67]	85.7918974494394	85.7918974494394	89.1547329604239
##	[70]	88.0243573111042	88.0935284240755	88.9306964520759
##	[73]	85.4679532807631	85.7918974494394	23.7376710249727
##	[76]	15.1577801254029	24.9886925719704	24.2404728290912
##	[79]	26.6355683864351	22.3400763210097	13.623003082505
##	[82]	22.0782249867995	30.1595141279304	25.1420036131407
##	[85]	3.63154719805616	6.38931525081601	1.72884903627705
##	[88]	2.92727324728095	0.708282895189088	5.32209689106514
##	[91]	3.84826167414853	-1.99162948378387	2.85849132257661
##	[94]	-3.38187467355245	-3.38187467355245	-5.20049618173059
##	[97]	-0.0014944306396889	-1.0497112989491	6.38931525081601
##	[100]	94.5545810862917	93.7124583712186	93.7124583712186
##	[103]	95.1416789686411	93.8063893549856	93.7124583712186
##	[106]	94.0488425962418	94.0488425962418	95.9368984442406
##	[109]	93.7124583712186	31.1235879106617	35.5908429935266
##	[112]	26.9062371423929	31.1235879106617	31.2011152915755
##	[115]	36.6131311056759	28.6172436472175	30.3304391921858
##	[118]	40.4377758925604	15.742125754879	10.2006621178395
##	[121]	11.779633554911	15.742125754879	10.5603988195599
##	[124]	13.2569087022766	11.2636643909429	12.4062020994797
##	[127]	13.2569087022766	11.779633554911	12.843746972241
##	[130]	15.742125754879	11.8966781267859	10.2006621178395
##	[133]	16.3212810420074	7.81708730848667	9.97540551763182
##	[136]	13.1611670807214	15.742125754879	1.49099538219921
##	[139]	4.66191611615316	5.54876818809764	1.05634705950217
##	[142]	98.7429629551913	94.9876399137823	99.2014482281224
##	[145]	98.8992226151565	98.8992226151565	100.732761691887
##	[148]	97.1779350052759	98.8992226151565	96.1980668431296
##	[151]	97.4815686102246	100.751090231888	18.8083708999008
##	[154]	15.9354599476648	18.8796415324266	17.4722259908005
##	[157]	22.4527937646778	14.6505091299054	18.8796415324266
##	[160]	14.6505091299054	15.9354599476648	19.5337549989991
##	[163]	21.9686666484096	17.9689327618874	46.5113048814522
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##	[169]	45.8835255714033	51.5955186982008	47.3897123928621
##	[172]	49.711177691601	51.5955186982008	32.0736124990205
##	[175]	27.3762302069556	27.3762302069556	26.3635360685975
##	[178]	25.5188712843979	32.1057214912373	28.2235520771519
##	[181]	30.1223010111622	29.9816886286196	26.5865100497985
##	[184]	28.9903692523612	28.9903692523612	95.3416314655189
##	[187]	92.1501640857422	96.0013113821641	88.7483040273701
##	[190]	93.4671684685238	96.7613712779717	87.5951564476289
##	[193]	87.5951564476289	87.5951564476289	93.0520764646784
##	[196]	23.7386985581272	23.7376710249727	20.4497999084468

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## [199] 28.7223720208226 28.2235520771519 31.3910738808481
## [202] 64.0445337979208 65.4157118258879 64.8760781213766
## [205] 64.049628770337 62.7407400782887 65.0775590139702
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## [211] 64.4760258372861 63.4674845120575 64.0445337979208
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## [217] 63.1403960071198 71.567593512926 74.3405473618968
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## [223] 72.7764587667007 74.2481249078696 37.0873216691733
## [226] 48.2177418340884 44.2679952218199 45.713738173288
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## [235] 63.231838104775 68.4037715546791 63.3874944350405
## [238] 68.4037715546791 71.9077702021575 74.4928896416173
## [241] 64.9876714869747 63.0248220847406 65.7800549724762
## [244] 63.0248220847406 69.9445309995409 72.592305370317
## [247] 51.2491272781992 53.8876998196464 51.9880363712293
## [250] 55.8400008201536 53.9127539598344 51.9880363712293
## [253] 36.0906011884843 33.9631294556251 33.3598093991981
## [256] 36.2143529375697 38.0381631417691 36.1781936034677
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## [262] 11.9211358280884 13.4632889688618 12.0540461900567
## [265] 11.3953457525533 12.7748230902551 11.9348583605424
## [268] 13.4632889688618 12.0540461900567 8.30900361046421
## [271] 12.1980678662142 11.2688130157088 11.9864589041794
## [274] 10.9950354413447 10.1113953150343 12.6483591873889
## [277] 11.2688130157088 14.1719275095482 12.3980666195425
## [280] 10.8239708371988 11.3085090280758 11.9864589041794
## [283] 11.421372357489 13.3699236838453 10.1113953150343
## [286] 9.22982836737784 30.7998020229608 33.435780949271
## [289] 37.3549867583241 29.3352887652631 33.435780949271
## [292] 35.4018470859387 34.4251549556674 34.839538592957
## [295] 27.5831990436261 33.2028542114815 26.5989144244865
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## attr(,"nn.index")
##      [,1] [,2] [,3]
## [1,] 744 270 735
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## [5,] 763 204 407
## [6,] 744 752 270
## [7,] 542 105 1070
## [8,] 930 693 728
## [9,] 409 566 183
## [10,] 380 328 566
## [11,] 114 113 1193
## [12,] 1193 623 114
## [13,] 94 92 680
## [14,] 661 775 1017
## [15,] 698 1094 287
## [16,] 1062 375 775
## [17,] 94 517 264
## [18,] 575 524 843

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## [19,] 420 894 287
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## [21,] 843 346 923
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## [23,] 119 214 1064
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## [198,] 0.0053982716 0.0281350503 0.031179368
## [199,] 0.0059226012 0.0093210795 0.009646546
## [200,] 0.0064879984 0.0109390580 0.011807344
## [201,] 0.0058441004 0.0065180247 0.006607894
## [202,] 0.0020772789 0.0036869290 0.005755267

```

```

## [203,] 0.0037823421 0.0049470523 0.005917139
## [204,] 0.0022197708 0.0027762994 0.008115178
## [205,] 0.0034102394 0.0041861253 0.004529042
## [206,] 0.0016361503 0.0055995349 0.007959730
## [207,] 0.0041988264 0.0043693927 0.005174438
## [208,] 0.0028514990 0.0036659531 0.003914213
## [209,] 0.0014793662 0.0022150547 0.006426687
## [210,] 0.0021239161 0.0050753014 0.008857585
## [211,] 0.0041694501 0.0054914073 0.008424031
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## [214,] 0.0022522944 0.0034865975 0.005933285
## [215,] 0.0015324788 0.0020561409 0.002449548
## [216,] 0.0056277413 0.0061039202 0.007564015
## [217,] 0.0024344821 0.0045550516 0.006642684
## [218,] 0.0048874499 0.0097054451 0.010006981
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## [220,] 0.0139707073 0.0158932531 0.016166412
## [221,] 0.0041605361 0.0055108220 0.011922739
## [222,] 0.0054792872 0.0107398908 0.014802500
## [223,] 0.0065022739 0.0110803987 0.013967902
## [224,] 0.0078607330 0.0132864787 0.015706294
## [225,] 0.0122392052 0.0359013991 0.056863356
## [226,] 0.0120526215 0.0154047740 0.016851425
## [227,] 0.0052923142 0.0241063253 0.024486630
## [228,] 0.0100345312 0.0129778494 0.013803914
## [229,] 0.0341097564 0.0363575911 0.053599023
## [230,] 0.0060771715 0.0184997101 0.019327135
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## [232,] 0.0043940122 0.0055731965 0.010196052
## [233,] 0.0060175773 0.0250703298 0.041163868
## [234,] 0.0154349187 0.0169932772 0.017879984
## [235,] 0.0058595878 0.0102691744 0.019103440
## [236,] 0.0058077764 0.0070480802 0.008024612
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## [238,] 0.0054873471 0.0082026960 0.008653317
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## [240,] 0.0032582992 0.0165198327 0.028539337
## [241,] 0.0120834873 0.0122343174 0.014022392
## [242,] 0.0079086868 0.0091786931 0.012031162
## [243,] 0.0094351564 0.0099399517 0.012871207
## [244,] 0.0194238595 0.0222264019 0.025653366
## [245,] 0.0060619189 0.0081531564 0.008176891
## [246,] 0.0184493101 0.0232361540 0.026718137
## [247,] 0.0021422135 0.0105773374 0.014658358
## [248,] 0.0033164623 0.0057528774 0.011600255
## [249,] 0.0024699052 0.0090169094 0.010971361
## [250,] 0.0030740163 0.0034382207 0.005305673
## [251,] 0.0042985503 0.0066895298 0.009723462
## [252,] 0.0058325387 0.0085500482 0.010166747
## [253,] 0.0074684109 0.0150492971 0.016312831
## [254,] 0.0058214431 0.0082712092 0.013086376
## [255,] 0.0161269292 0.0253021338 0.025597519
## [256,] 0.0025085097 0.0030786506 0.004562693

```

```
## [257,] 0.0041995764 0.0053900061 0.005623898
## [258,] 0.0249909918 0.0260378938 0.026709741
## [259,] 0.0058309398 0.0095394079 0.012517816
## [260,] 0.0023723241 0.0039079594 0.004567344
## [261,] 0.0319833598 0.0400239083 0.040803964
## [262,] 0.0016763175 0.0024150045 0.002756863
## [263,] 0.0058060843 0.0075104069 0.010010503
## [264,] 0.0014464776 0.0044047569 0.004576363
## [265,] 0.0042239411 0.0047686031 0.005574440
## [266,] 0.0062880906 0.0078085217 0.008013454
## [267,] 0.0016666514 0.0024954827 0.002502261
## [268,] 0.0095407996 0.0098375059 0.013432431
## [269,] 0.0014392620 0.0016080452 0.005306622
## [270,] 0.0021010485 0.0062679879 0.006745098
## [271,] 0.0016319530 0.0025009592 0.005607582
## [272,] 0.0017100351 0.0117892818 0.012178453
## [273,] 0.0053110502 0.0084343223 0.014121004
## [274,] 0.0033317656 0.0033887486 0.008587318
## [275,] 0.0080674253 0.0094158862 0.011422481
## [276,] 0.0141563454 0.0198476482 0.021853877
## [277,] 0.0082382362 0.0114188167 0.016054662
## [278,] 0.0079804447 0.0136905048 0.019571273
## [279,] 0.0072292358 0.0079587639 0.010400479
## [280,] 0.0042729632 0.0127299654 0.014858992
## [281,] 0.0090661658 0.0142203408 0.016608237
## [282,] 0.0066865000 0.0070989250 0.015164115
## [283,] 0.0128704547 0.0157582989 0.016112735
## [284,] 0.0148065012 0.0153489765 0.020762781
## [285,] 0.0083131454 0.0121416809 0.013210047
## [286,] 0.0134635063 0.0146606238 0.016268883
## [287,] 0.0123610620 0.0129391047 0.015993348
## [288,] 0.0111717104 0.0184331372 0.020156436
## [289,] 0.0156076949 0.0221355506 0.022309551
## [290,] 0.0493077997 0.0572296191 0.057670841
## [291,] 0.0106153987 0.0203111085 0.025867460
## [292,] 0.0029954709 0.0162363160 0.018803793
## [293,] 0.0188794310 0.0250651588 0.025200066
## [294,] 0.0002963327 0.0086493576 0.025006364
## [295,] 0.0058301426 0.0525729116 0.055900199
## [296,] 0.0025680583 0.0031571349 0.019799079
## [297,] 0.0183756709 0.0209572537 0.021698626
## [298,] 0.0081326021 0.0322102979 0.041158514
## [299,] 0.0143219644 0.0376402656 0.044710546
## [300,] 0.0262466421 0.0281918067 0.033455357
## 246 Levels: -0.0014944306396889 -1.0497112989491 ... 99.2014482281224
```

```
binary5<- knn(train, test,cl=target_category, k=5)
binary5
```

```
## [1] 71.4078929301598 71.4078929301598 69.0739946567631
## [4] 68.4102850870777 68.6949569776664 70.8846909680027
## [7] 65.3713769462872 48.2052856301826 48.2632879207192
## [10] 47.5868812700584 47.14664354268 47.8363722494385
## [13] 40.5658722922426 43.5777617976381 42.4761666858862
```


##	[16]	44.3086454540258	40.5658722922426	44.4135582895176
##	[19]	42.2988896050884	43.0049521681032	44.4135582895176
##	[22]	44.3086454540258	40.9013558062896	43.0049521681032
##	[25]	40.9013558062896	90.4249756131192	92.9234455069283
##	[28]	89.84541902125	95.0843728071748	96.0947536603643
##	[31]	92.8914066509878	93.7124583712186	92.4502755326176
##	[34]	95.0843728071748	8.16318993454417	11.754786803879
##	[37]	11.2105682234415	17.2158328741169	8.2210665115028
##	[40]	10.77938098843	15.6323978584128	14.7660916611475
##	[43]	59.0394837787253	59.9106374968867	43.9913152671632
##	[46]	47.3708251011915	44.3335222957169	34.8587696847959
##	[49]	40.9256967620506	43.4820444082376	43.3479980157971
##	[52]	43.9913152671632	1.90684931157917	13.4655555388728
##	[55]	7.95578845765198	10.625257337026	10.5797585280614
##	[58]	0.0566420864278663	9.16841873469325	8.77596447364277
##	[61]	7.58091983282684	11.5685110029631	9.82231090247629
##	[64]	9.05802278498249	87.6314899225871	87.740174000388
##	[67]	85.7918974494394	85.7918974494394	87.8893741677763
##	[70]	87.2753232812567	87.8893741677763	87.6314899225871
##	[73]	85.4679532807631	85.7918974494394	23.7376710249727
##	[76]	14.1833789894173	24.2404728290912	23.8631100845223
##	[79]	26.6355683864351	22.3400763210097	13.4617013560906
##	[82]	22.0782249867995	28.9776809342851	25.1420036131407
##	[85]	2.55070713929827	6.38931525081601	1.72884903627705
##	[88]	2.92727324728095	0.708282895189088	5.08470185668165
##	[91]	2.92727324728095	-3.07239408639785	1.29830523653385
##	[94]	-5.20049618173059	-4.78181540983619	-5.20049618173059
##	[97]	-0.0014944306396889	-1.0497112989491	6.38931525081601
##	[100]	94.5545810862917	93.7124583712186	93.7124583712186
##	[103]	95.1416789686411	93.8063893549856	93.7124583712186
##	[106]	94.0488425962418	94.0488425962418	94.9562093877766
##	[109]	93.7124583712186	30.5247039405511	35.5908429935266
##	[112]	26.5997226348784	29.6341514532214	30.8524207545466
##	[115]	35.667400650134	26.5997226348784	30.3304391921858
##	[118]	38.3303796320241	14.9402504294065	10.2006621178395
##	[121]	10.6923993875263	13.6069448817296	10.3958077426559
##	[124]	12.843746972241	11.2636643909429	11.2636643909429
##	[127]	12.843746972241	11.779633554911	11.779633554911
##	[130]	14.9402504294065	10.5603988195599	10.2006621178395
##	[133]	14.9402504294065	7.81708730848667	9.97540551763182
##	[136]	12.0896686553365	14.1833789894173	0.808451642170988
##	[139]	4.66191611615316	5.26315040819022	1.05634705950217
##	[142]	98.0604315144233	93.6923906653869	98.7429629551913
##	[145]	98.8992226151565	97.8960594081542	100.675400045897
##	[148]	96.6228257424291	98.8992226151565	96.1980668431296
##	[151]	97.4815686102246	100.721176750452	18.8083708999008
##	[154]	14.6505091299054	18.5996756837259	17.4722259908005
##	[157]	22.1273870624737	14.2008384255937	18.5996756837259
##	[160]	14.6505091299054	14.6505091299054	19.0996883385041
##	[163]	21.3261950836893	17.9689327618874	45.9612579430931
##	[166]	49.8611838549442	47.3897123928621	41.0263455413907
##	[169]	44.2004751710441	49.8611838549442	47.3897123928621
##	[172]	49.2253552421211	51.5955186982008	30.7837186455348
##	[175]	27.3762302069556	27.3762302069556	26.1361272382196

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## [178] 25.0856573940553 31.5556684038458 26.5865100497985
## [181] 29.9816886286196 29.9816886286196 25.9307179291728
## [184] 28.2269365771946 28.9903692523612 94.4290635183997
## [187] 92.1501640857422 95.9615541359033 88.7483040273701
## [190] 93.4671684685238 95.7647365918306 87.5951564476289
## [193] 87.5951564476289 87.5951564476289 92.985399374983
## [196] 23.7386985581272 23.7376710249727 20.4497999084468
## [199] 27.8116695452307 26.5865100497985 30.7837186455348
## [202] 63.7891159287276 65.1724808391298 64.6036577756771
## [205] 64.049628770337 62.7407400782887 64.9034471037111
## [208] 64.186350066405 64.6036577756771 63.1403960071198
## [211] 64.2366262655791 63.1403960071198 64.0445337979208
## [214] 64.6036577756771 64.8279609919264 62.5428636362376
## [217] 63.1403960071198 71.1944416204399 72.5626915999491
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## [223] 72.7764587667007 72.9034394847096 37.0873216691733
## [226] 47.7347542264043 44.2679952218199 44.2679952218199
## [229] 41.6499879967213 47.4477581973002 41.6499879967213
## [232] 45.713738173288 37.0873216691733 44.2679952218199
## [235] 63.231838104775 68.4037715546791 63.3874944350405
## [238] 68.16583709493 71.6562585419623 72.592305370317
## [241] 64.9876714869747 63.0248220847406 63.8715320428993
## [244] 58.5259174337561 69.7149155746094 72.4419862618214
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## [250] 54.9317425093447 53.3611050626799 51.9880363712293
## [253] 35.8934052140617 33.5462757860823 33.3598093991981
## [256] 35.9258344819961 38.0381631417691 36.1781936034677
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## [262] 11.9211358280884 12.9588243634831 11.3953457525533
## [265] 11.2396289119513 12.0540461900567 11.9348583605424
## [268] 13.4632889688618 11.3953457525533 8.30900361046421
## [271] 12.1113496431327 11.0489316021356 11.0489316021356
## [274] 10.1170394407889 10.1113953150343 12.4534445661635
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## [280] 10.4986998135763 11.3085090280758 11.0489316021356
## [283] 11.421372357489 11.8891428083768 10.1113953150343
## [286] 9.22982836737784 30.7998020229608 33.0944377676148
## [289] 36.3512425284423 29.3352887652631 33.0944377676148
## [292] 33.4704626894992 34.4251549556674 34.0576385001463
## [295] 26.5989144244865 33.2028542114815 26.5989144244865
## [298] 36.3512425284423 26.5989144244865 24.8981599644943
## attr(,"nn.index")
##      [,1] [,2] [,3] [,4] [,5]
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## [4,] 752 219 70 969 270
## [5,] 763 204 407 18 1186
## [6,] 744 752 270 1018 18
## [7,] 542 105 1070 935 969
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## [9,] 409 566 183 438 240
## [10,] 380 328 566 1003 1051
## [11,] 114 113 1193 623 884

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## [12,] 1193 623 114 405 610
## [13,] 94 92 680 264 122
## [14,] 661 775 1017 479 162
## [15,] 698 1094 287 1031 420
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## [65,] 227 382 490 168 1174

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```

## [66,] 227 382 926 168 471
## [67,] 391 856 468 583 536
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## [69,] 1069 373 867 700 991
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## [72,] 1174 373 227 700 490
## [73,] 778 58 490 515 471
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## [86,] 995 299 20 839 428
## [87,] 888 751 444 149 1074
## [88,] 999 149 951 262 918
## [89,] 534 426 425 1074 751
## [90,] 1122 20 579 299 1066
## [91,] 999 918 951 393 149
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## [93,] 1016 960 66 262 425
## [94,] 602 560 281 369 1120
## [95,] 281 560 64 602 180
## [96,] 369 602 180 560 281
## [97,] 426 1120 534 751 1074
## [98,] 807 64 116 101 504
## [99,] 995 299 20 839 765
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## [101,] 440 178 631 633 640
## [102,] 178 440 631 640 611
## [103,] 1181 11 1020 236 340
## [104,] 197 1154 662 50 205
## [105,] 631 633 440 178 827
## [106,] 476 1192 905 1107 779
## [107,] 507 1192 476 21 905
## [108,] 1033 236 229 1139 453
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## [110,] 835 1115 819 1007 1014
## [111,] 648 903 1063 206 153
## [112,] 1098 538 133 628 915
## [113,] 1115 819 835 1007 628
## [114,] 736 448 367 359 146
## [115,] 206 406 1179 738 648
## [116,] 1098 133 628 538 915
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## [118,] 1038 589 1132 429 746
## [119,] 642 1163 1168 828 1102

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## [120,]    1  540  770  921  813
## [121,] 1171  431  813  540  571
## [122,] 1168 1163  828  100  246
## [123,]  676  161  817 1155  592
## [124,]  431 1168 1102 1171  828
## [125,]  305  263 1096 1071    2
## [126,]  305  263 1071 1096  410
## [127,]  431 1168 1102 1171  828
## [128,] 1171  431  813  100  246
## [129,] 1171  431  100  246  813
## [130,] 1168  828 1163  642 1102
## [131,]  263  817 1071 1096  676
## [132,]    1  921  770  803  540
## [133,]  828  642 1163 1168 1102
## [134,]  399  676  177 1096  817
## [135,]  676  399 1096  263  817
## [136,]  467  354  552  770  158
## [137,] 1163  642 1168   98  823
## [138,]  909  750   80  503  210
## [139,]  210   80  750  184  408
## [140,]  650  759 1101  167   23
## [141,]  185   71  965 1176  477
## [142,]  971  754  880  733  963
## [143,] 1162  805  137  261  696
## [144,]  816  963  880  754  302
## [145,]  816  800  302  430 1042
## [146,]  800  121 1042  614  816
## [147,]  293   25  912 1042  302
## [148,]  418 1027  599  445  421
## [149,]  800 1042  912  121  816
## [150,]  805  137  228  961  404
## [151,]  988  961  733  754    7
## [152,]  249 1005  430  302   25
## [153,]  821  966  737 1055  741
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```

```
binary10<- knn(train, test,cl=target_category, k=10)
binary10
```

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##	[5,]	763	204	407	18	1186	318	1185	376	103	279
##	[6,]	744	752	270	1018	18	103	376	138	219	969
##	[7,]	542	105	1070	935	969	771	565	306	219	70
##	[8,]	930	693	728	454	207	240	46	222	666	438
##	[9,]	409	566	183	438	240	1003	380	265	1104	328
##	[10,]	380	328	566	1003	1051	1056	409	265	183	1142
##	[11,]	114	113	1193	623	884	160	610	405	962	913
##	[12,]	1193	623	114	405	610	962	113	722	1053	1081
##	[13,]	94	92	680	264	122	1064	927	1041	37	517
##	[14,]	661	775	1017	479	162	368	375	1062	575	894
##	[15,]	698	1094	287	1031	420	894	239	524	1041	37
##	[16,]	1062	375	775	661	368	479	824	1017	162	151
##	[17,]	94	517	264	122	581	92	1035	1041	37	743
##	[18,]	575	524	843	162	923	346	287	479	239	368
##	[19,]	420	894	287	1118	1031	927	698	1064	1094	524
##	[20,]	287	894	420	698	524	1094	575	162	1031	239
##	[21,]	843	346	923	575	524	239	483	364	368	162
##	[22,]	775	479	661	162	368	575	375	1062	1017	524
##	[23,]	119	214	1064	680	92	1118	122	94	264	927
##	[24,]	894	287	420	524	162	575	698	1094	479	661
##	[25,]	214	1064	1118	680	119	92	927	264	420	94
##	[26,]	709	656	1065	179	792	563	67	50	1154	140
##	[27,]	792	179	50	1154	205	662	709	140	656	598
##	[28,]	370	702	620	859	489	1128	63	801	325	360
##	[29,]	664	197	108	498	1191	1083	758	1154	205	669
##	[30,]	1083	498	108	758	664	1191	197	141	472	669
##	[31,]	669	1095	197	662	598	1198	881	664	108	472
##	[32,]	633	764	827	440	631	309	178	640	1107	132
##	[33,]	179	709	656	792	563	1065	50	1154	140	67
##	[34,]	669	108	197	1095	664	472	498	148	662	1083
##	[35,]	242	780	679	714	756	989	174	832	862	1034
##	[36,]	674	1173	862	756	714	1178	967	521	1034	786
##	[37,]	1178	1173	674	862	348	714	416	756	481	848
##	[38,]	663	486	645	347	96	899	818	773	947	522
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##	[42,]	879	906	522	521	347	645	967	352	786	674
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##	[45,]	964	111	875	858	377	1175	870	544	5	516
##	[46,]	531	395	170	692	798	525	13	632	157	1054
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##	[48,]	648	903	1063	448	153	206	840	434	290	332
##	[49,]	384	166	1024	245	567	1026	313	516	153	983
##	[50,]	329	488	321	787	703	333	911	5	667	544
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##	[59,]	52	694	972	739	1044	974	622	1151	512	887
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##	[75,]	251	1060	415	1049	436	729	202	221	169	511
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##	[85,]	393	999	918	444	149	951	116	888	262	751
##	[86,]	995	299	20	839	428	357	765	579	646	1122
##	[87,]	888	751	444	149	1074	116	534	262	999	393
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##	[92,]	281	64	1120	426	602	560	807	534	751	425
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##	[140,]	650	759	1101	167	23	349	550	62	401	495
##	[141,]	185	71	965	1176	477	684	69	1046	781	1183
##	[142,]	971	754	880	733	963	988	7	961	529	89
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##	[153,]	821	966	737	1055	741	901	675	657	1126	1145
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## [175,]	916	1006	555	172	594	351	317	949	510	233
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## [177,]	277	296	557	91	1050	1164	846	547	844	317
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## [180,]	732	295	902	215	949	308	35	351	1150	594
## [181,]	334	549	381	1002	314	308	256	1028	716	1153
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## [186,]	1095	669	881	164	466	148	258	472	336	1198
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## [196,]	26	51	907	727	106	844	720	470	846	874
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## [200,]	732	902	295	949	215	308	351	594	233	916
## [201,]	381	314	1153	716	549	447	334	76	144	1002
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## [205,]	931	600	48	257	1078	530	211	753	1040	643
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## [218,]	959	55	601	499	841	316	1001	74	304	615

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## [235,]	1123	124	808	836	1112	681	147	708	1029	388
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## [239,]	1008	576	678	212	435	1152	126	772	869	768
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## [247,]	1195	954	464	260	659	196	231	854	1079	1025
## [248,]	1144	711	1025	978	260	402	422	574	721	954
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## [250,]	386	3	519	1011	248	84	619	190	273	970
## [251,]	248	190	231	854	1113	196	386	1054	519	3
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## [253,]	1197	1088	83	291	65	608	537	230	275	123
## [254,]	203	603	682	1085	1099	243	130	175	335	630
## [255,]	625	232	939	603	358	345	1085	609	12	203
## [256,]	630	344	1099	268	175	561	734	682	203	897
## [257,]	442	794	897	1036	802	53	266	561	268	65
## [258,]	537	457	581	230	394	517	1043	743	1035	938
## [259,]	198	891	943	1091	609	345	358	1019	451	822
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## [262,]	896	88	326	1089	710	29	322	497	512	1141
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## [272,]	834	691	837	585	383	855	851	142	1052	417

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## [294,] 0.032238498 0.032898231 0.036115464 0.037845444 0.037890380
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## [299,] 0.054143700 0.054603772 0.059909987 0.061741612 0.063630891
## [300,] 0.052062642 0.064595895 0.068151215 0.068948125 0.075194087
## 223 Levels: -0.0014944306396889 -0.626121741531422 ... 99.8525861517281
```

```
binary15<- knn(train, test,cl=target_category, k=15)
binary15
```

```
## [1] 68.6949569776664 68.0938181940472 68.1557584053295
## [4] 67.2082831025027 65.7799426366212 68.4102850870777
## [7] 64.3718987048263 47.3195922781614 46.4054497290645
## [10] 47.3282354186266 45.0557880243366 46.1305894540954
## [13] 40.5658722922426 43.0049521681032 41.7833368550991
## [16] 43.1523172649838 39.7879829760094 43.2759950309956
## [19] 41.7604501219249 42.0583282978465 43.7189948267244
## [22] 43.2759950309956 39.4246994789974 42.2988896050884
## [25] 40.5658722922426 90.4249756131192 90.4249756131192
## [28] 87.5951564476289 93.8063893549856 95.0843728071748
## [31] 92.8914066509878 93.7124583712186 90.4249756131192
## [34] 92.8914066509878 6.42853407248331 10.77938098843
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##	[37]	8.94232854322852	14.7660916611475	7.92072846265277
##	[40]	8.16318993454417	13.465555388728	12.1172171968014
##	[43]	56.0987717648814	59.0394837787253	43.0229633519505
##	[46]	45.6779027657198	43.0229633519505	32.9612531296713
##	[49]	39.4717128259236	41.1791661046975	42.1061216443865
##	[52]	43.0229633519505	0.744330029935204	10.77938098843
##	[55]	5.54876818809764	9.05802278498249	7.95578845765198
##	[58]	-0.626121741531422	9.05802278498249	6.15371885983455
##	[61]	6.15371885983455	9.63027851413816	7.9931214246027
##	[64]	7.03828507933107	87.24750117495	87.24750117495
##	[67]	85.7731976005309	83.9080978224609	87.0089718846946
##	[70]	86.496747628119	87.0089718846946	87.24750117495
##	[73]	85.4679532807631	83.9080978224609	22.3400763210097
##	[76]	11.8966781267859	23.0382798831813	22.4893159565386
##	[79]	25.1420036131407	20.7776255890691	11.2636643909429
##	[82]	20.7776255890691	26.6355683864351	23.8631100845223
##	[85]	1.72884903627705	4.08631442506944	-0.0014944306396889
##	[88]	1.24783644871729	-1.0497112989491	3.1988117268747
##	[91]	1.72884903627705	-4.78181540983619	1.24783644871729
##	[94]	-5.20049618173059	-5.20049618173059	-5.20049618173059
##	[97]	-1.99162948378387	-1.99162948378387	4.08631442506944
##	[100]	92.9234455069283	93.7124583712186	93.3842300944617
##	[103]	93.3842300944617	92.8914066509878	93.7124583712186
##	[106]	93.7124583712186	93.7124583712186	94.2257424547521
##	[109]	93.7124583712186	27.9658946703809	32.9612531296713
##	[112]	24.5057012777584	27.9658946703809	30.3304391921858
##	[115]	31.1235879106617	24.5057012777584	25.0652995015891
##	[118]	37.0059477567262	12.843746972241	9.23419617051404
##	[121]	10.2006621178395	11.2881270432422	7.81708730848667
##	[124]	10.6923993875263	9.97540551763182	9.97540551763182
##	[127]	10.6923993875263	10.3958077426559	10.3958077426559
##	[130]	11.779633554911	9.97540551763182	9.23419617051404
##	[133]	12.843746972241	7.81708730848667	7.81708730848667
##	[136]	10.2006621178395	12.843746972241	-0.802080462871601
##	[139]	0.808451642170988	2.26385097539127	-2.82595849963402
##	[142]	97.1548339179301	93.6923906653869	97.4164184297245
##	[145]	97.6559951334489	97.1779350052759	97.5886825969056
##	[148]	96.6228257424291	97.319561728261	94.9876399137823
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##	[154]	14.2008384255937	16.4213310157474	16.0876084602546
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##	[160]	10.5542851965963	14.6505091299054	14.7820751153261
##	[163]	18.6436137873127	14.6505091299054	44.1383312746874
##	[166]	47.4926814121096	44.4577839771128	40.4377758925604
##	[169]	42.8071861419159	47.4043694106635	43.7784058752754
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## 209 Levels: -0.0014944306396889 -0.626121741531422 ... 98.7429629551913
```

```
binary20<- knn(train, test,cl=target_category, k=20)
binary20
```

```
## [1] 68.6014493834819 67.9053219762667 67.2082831025027
## [4] 67.1394721380322 65.7799426366212 67.5418511219557
## [7] 64.3718987048263 45.8835255714033 45.8835255714033
## [10] 46.4054497290645 45.0557880243366 45.0557880243366
## [13] 39.4246994789974 41.9533294088145 41.6361320459424
## [16] 43.0049521681032 39.4246994789974 42.4761666858862
## [19] 41.5049256896621 41.7833368550991 43.7189948267244
## [22] 43.0049521681032 38.6303670827825 42.0583282978465
## [25] 39.4246994789974 90.4249756131192 90.4249756131192
## [28] 87.5951564476289 92.8914066509878 93.8063893549856
## [31] 90.8873122328356 93.7124583712186 90.4249756131192
## [34] 92.8914066509878 5.82551399021638 8.94232854322852
## [37] 8.94232854322852 13.6166950955745 5.82551399021638
## [40] 8.16318993454417 12.006713156172 11.754786803879
## [43] 56.0987717648814 57.3923325604887 42.0251373958012
## [46] 44.9198657378566 43.0229633519505 31.738680231249
## [49] 39.4717128259236 41.1791661046975 41.3300704030372
## [52] 43.0229633519505 0.744330029935204 10.77938098843
## [55] 5.26315040819022 9.05802278498249 7.92072846265277
## [58] -0.626121741531422 8.73646435691878 6.15371885983455
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## [64]	6.79867538435577	86.6896530283807	86.6896530283807
## [67]	83.9080978224609	83.9080978224609	87.0089718846946
## [70]	85.7918974494394	87.0089718846946	86.6896530283807
## [73]	85.4679532807631	83.9080978224609	21.1800420637313
## [76]	10.5603988195599	22.4146176141488	22.0782249867995
## [79]	24.2714708511115	20.2182759361716	11.2636643909429
## [82]	20.2182759361716	26.3715628488597	23.0382798831813
## [85]	0.708282895189088	3.84826167414853	-0.0014944306396889
## [88]	0.708282895189088	-1.99162948378387	2.85849132257661
## [91]	1.24783644871729	-5.20049618173059	0.708282895189088
## [94]	-5.20049618173059	-5.20049618173059	-5.20049618173059
## [97]	-3.07239408639785	-3.38187467355245	3.84826167414853
## [100]	92.4522818345856	93.3842300944617	93.3842300944617
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## [109]	93.401927840133	27.9658946703809	32.9612531296713
## [112]	22.4113216040115	26.5997226348784	30.3304391921858
## [115]	31.1235879106617	24.5057012777584	25.0652995015891
## [118]	33.8805829375804	11.779633554911	7.81708730848667
## [121]	10.2006621178395	10.6923993875263	7.81708730848667
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## [130]	11.2881270432422	7.81708730848667	9.23419617051404
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## [139]	-0.802080462871601	1.90684931157917	-2.82595849963402
## [142]	97.1548339179301	93.6923906653869	97.1548339179301
## [145]	97.2358121154052	96.6228257424291	97.3809410791483
## [148]	96.1980668431296	97.1779350052759	94.9876399137823
## [151]	96.1980668431296	97.9035109586548	14.6505091299054
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## [172]	47.3897123928621	47.4043694106635	28.8747552603154
## [175]	26.4939928038479	26.4939928038479	24.2481866701429
## [178]	23.7386985581272	29.2647969026384	25.3353505527909
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## [196]	22.2171956322553	22.3400763210097	20.1761071253617
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## [202]	62.7407400782887	63.7891159287276	63.8403725596116
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## [223] 71.567593512926      71.567593512926      33.8333352263568
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## [238] 66.0416004716788      69.1686512302178      69.9445309995409
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##	[29,]	664	197	108	498	1191	1083	758	1154	205	669	662	141	50
##	[30,]	1083	498	108	758	664	1191	197	141	472	669	143	1196	148
##	[31,]	669	1095	197	662	598	1198	881	664	108	472	164	148	466
##	[32,]	633	764	827	440	631	309	178	640	1107	132	1139	942	476
##	[33,]	179	709	656	792	563	1065	50	1154	140	67	205	1020	662
##	[34,]	669	108	197	1095	664	472	498	148	662	1083	881	258	1191
##	[35,]	242	780	679	714	756	989	174	832	862	1034	22	408	786
##	[36,]	674	1173	862	756	714	1178	967	521	1034	786	906	522	242
##	[37,]	1178	1173	674	862	348	714	416	756	481	848	967	521	242
##	[38,]	663	486	645	347	96	899	818	773	947	522	879	300	352
##	[39,]	989	714	242	174	862	756	832	780	1178	42	416	1173	348
##	[40,]	22	780	1034	786	242	967	352	756	300	714	521	862	522
##	[41,]	879	347	906	645	522	521	352	967	783	786	1034	22	674
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##	[43,]	208	371	616	683	790	413	595	389	1177	707	40	182	793
##	[44,]	1140	518	707	365	595	612	790	946	683	1138	310	973	311
##	[45,]	964	111	875	858	377	1175	870	544	5	516	667	703	157
##	[46,]	531	395	170	692	798	525	13	632	157	1054	1113	653	858
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##	[48,]	648	903	1063	448	153	206	840	434	290	332	957	1026	313
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##	[53,]	401	152	167	857	43	650	278	23	759	1183	1101	1058	550
##	[54,]	1034	786	967	22	352	521	522	756	780	714	906	862	879
##	[55,]	1048	458	877	42	1167	495	62	416	481	348	23	622	1151
##	[56,]	78	974	848	481	348	739	1167	455	694	512	416	52	526
##	[57,]	1178	416	348	862	714	989	1173	756	481	42	1048	674	1167
##	[58,]	181	593	857	152	278	781	292	684	401	69	1183	43	477
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##	[65,]	227	382	490	168	1174	58	471	926	660	373	324	700	282
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##	[67,]	391	856	468	583	536	216	1093	297	1075	558	118	513	760
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##	[75,]	251	1060	415	1049	436	729	202	221	169	511	883	1130	885
##	[76,]	410	672	2	98	823	1071	1067	305	246	263	100	817	1163
##	[77,]	1049	169	1110	1060	415	251	327	1114	436	580	729	86	885
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##	[79,]	580	545	86	527	647	1110	811	68	461	1103	169	1114	475
##	[80,]	511	886	1130	221	883	125	202	1073	456	729	993	487	251

##	[81,]	2	305	410	1071	672	263	795	218	456	125	993	1096	98
##	[82,]	886	1130	1073	883	221	511	202	487	135	729	125	993	90
##	[83,]	1045	484	861	68	811	527	461	545	647	580	1103	731	847
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##	[85,]	393	999	918	444	149	951	116	888	262	751	1076	1074	357
##	[86,]	995	299	20	839	428	357	765	579	646	1122	450	102	1066
##	[87,]	888	751	444	149	1074	116	534	262	999	393	426	425	918
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##	[100,]	140	205	50	1154	303	141	1020	1191	143	664	1196	179	197
##	[101,]	440	178	631	633	640	764	827	1139	476	611	309	390	1107
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##	[106,]	476	1192	905	1107	779	21	764	309	507	440	633	827	631
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##	[110,]	835	1115	819	1007	1014	957	628	1098	434	785	283	777	1045
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##	[118,]	1038	589	1132	429	746	320	670	738	730	1179	406	330	36
##	[119,]	642	1163	1168	828	1102	100	98	431	246	823	1171	672	176
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## [135,]	676	399	1096	263	817	177	1071	161	1155	592	1067	305	571
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## [139,]	210	80	750	184	408	679	503	868	965	717	71	1046	909
## [140,]	650	759	1101	167	23	349	550	62	401	495	719	458	43
## [141,]	185	71	965	1176	477	684	69	1046	781	1183	503	301	586
## [142,]	971	754	880	733	963	988	7	961	529	89	424	473	228
## [143,]	1162	805	137	261	696	492	228	961	529	404	988	473	733
## [144,]	816	963	880	754	302	89	430	971	7	800	1170	482	473
## [145,]	816	800	302	430	1042	963	89	1170	880	614	482	7	754
## [146,]	800	121	1042	614	816	912	1170	482	599	1027	89	302	33
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## [148,]	418	1027	599	445	421	33	614	462	1170	482	800	89	404
## [149,]	800	1042	912	121	816	614	25	302	1170	430	482	599	1027
## [150,]	805	137	228	961	404	473	988	1162	529	733	7	696	89
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## [153,]	821	966	737	1055	741	901	675	657	1126	1145	496	776	1137
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## [165,]	117	267	45	936	195	437	201	688	104	587	653	460	597
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##	[91,]	1076	20	1122	299	534	1066	425
##	[92,]	180	444	149	369	262	393	999
##	[93,]	999	918	426	579	444	357	393
##	[94,]	807	1016	116	444	149	262	960
##	[95,]	1074	888	444	149	101	262	504
##	[96,]	1016	807	262	116	149	444	960
##	[97,]	281	393	999	918	951	1016	602
##	[98,]	149	1074	560	999	425	918	602
##	[99,]	951	918	863	960	999	1076	66
##	[100,]	1181	792	11	662	758	709	340
##	[101,]	132	1033	556	942	67	229	563
##	[102,]	229	132	556	309	942	476	236
##	[103,]	67	611	1139	229	141	205	50

## [104,]	758	669	143	498	108	1083	1020
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## [106,]	178	942	640	132	556	423	1139
## [107,]	178	640	942	132	556	423	1139
## [108,]	1020	631	942	67	178	563	827
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## [110,]	480	1103	840	133	206	461	406
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## [112,]	1103	819	1007	1014	86	1114	135
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## [117,]	840	224	283	1121	448	434	1014
## [118,]	587	639	1082	908	480	785	72
## [119,]	1067	331	410	803	813	467	552
## [120,]	161	417	177	354	383	1102	399
## [121,]	592	770	823	98	1067	828	552
## [122,]	672	571	803	161	410	540	817
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## [124,]	98	770	823	642	467	161	1067
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## [127,]	571	98	823	467	642	1	161
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## [131,]	672	246	592	100	2	571	177
## [132,]	571	142	592	1155	1102	691	161
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##      [,18]      [,19]      [,20]
## [1,] 0.061818919 0.06379358 0.06400777
## [2,] 0.053253244 0.05475119 0.05732490
## [3,] 0.044871693 0.04553346 0.04631394
## [4,] 0.036262802 0.03926610 0.04090186
## [5,] 0.037412381 0.03795661 0.03861430
## [6,] 0.053711113 0.05542757 0.05573821
## [7,] 0.042342724 0.04640243 0.04970725
## [8,] 0.033363287 0.03487491 0.03501028
## [9,] 0.027250830 0.02894465 0.02905488
## [10,] 0.021170417 0.02252819 0.02429965
## [11,] 0.030244052 0.03044016 0.03902944
## [12,] 0.033185675 0.03412736 0.03576609
## [13,] 0.016401312 0.01678413 0.01734383
## [14,] 0.020959738 0.02122709 0.02292943
## [15,] 0.017895714 0.01831882 0.01851266
## [16,] 0.028475873 0.02874880 0.02875495
## [17,] 0.017975415 0.01946126 0.01969083
## [18,] 0.018480557 0.02079975 0.02080097
## [19,] 0.015310778 0.01543871 0.01651966
## [20,] 0.015733311 0.01679453 0.01713587
## [21,] 0.021719955 0.02223326 0.02434717
## [22,] 0.018656388 0.01917933 0.02019430
## [23,] 0.023150851 0.02406285 0.02456689
## [24,] 0.015788360 0.01621620 0.01646573
## [25,] 0.022311899 0.02254525 0.02332684
## [26,] 0.041353979 0.04165657 0.04183009
## [27,] 0.030627428 0.03399708 0.03430044
## [28,] 0.053658485 0.05413635 0.05517183
## [29,] 0.031577291 0.03159433 0.03174141
## [30,] 0.037005163 0.03706450 0.03794925
## [31,] 0.032860450 0.03330021 0.03358908
## [32,] 0.029765251 0.03099004 0.03414849

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## [33,] 0.035303155 0.03585461 0.03778014
## [34,] 0.032514614 0.03256419 0.03334910
## [35,] 0.042744856 0.04294246 0.04305639
## [36,] 0.033691504 0.03545280 0.03923240
## [37,] 0.037278820 0.03941449 0.04009894
## [38,] 0.047576349 0.05015482 0.05043654
## [39,] 0.038681346 0.03931992 0.03996207
## [40,] 0.044806014 0.04574188 0.04676063
## [41,] 0.043218380 0.04467976 0.04677585
## [42,] 0.041666102 0.04211377 0.04477739
## [43,] 0.031321049 0.03152999 0.03336449
## [44,] 0.047022752 0.04805435 0.04843260
## [45,] 0.024812512 0.02545812 0.02558093
## [46,] 0.048338565 0.04907142 0.04963440
## [47,] 0.021827197 0.02284491 0.02306956
## [48,] 0.043706361 0.04375221 0.04400462
## [49,] 0.028930243 0.03069042 0.03115566
## [50,] 0.026423500 0.02648539 0.02688057
## [51,] 0.022438180 0.02356335 0.02505637
## [52,] 0.027849764 0.02836807 0.02878823
## [53,] 0.032885769 0.03309909 0.03313255
## [54,] 0.031619498 0.03227237 0.03815642
## [55,] 0.031209526 0.03127448 0.03186173
## [56,] 0.032461899 0.03289656 0.03334364
## [57,] 0.034776262 0.03492416 0.04112832
## [58,] 0.043777059 0.04477055 0.04490042
## [59,] 0.021892005 0.02190064 0.02391156
## [60,] 0.028593997 0.02923697 0.03043191
## [61,] 0.025470762 0.02585345 0.02635551
## [62,] 0.019166216 0.02056549 0.02096273
## [63,] 0.029716779 0.03306488 0.03411497
## [64,] 0.026259549 0.02631127 0.02812271
## [65,] 0.024481683 0.02528366 0.02613323
## [66,] 0.023621764 0.02541207 0.02576882
## [67,] 0.052854983 0.05364127 0.05424857
## [68,] 0.032965992 0.03481255 0.03548159
## [69,] 0.046033418 0.04655742 0.04876133
## [70,] 0.026172220 0.02669443 0.02728627
## [71,] 0.042734884 0.04343495 0.04696798
## [72,] 0.030725027 0.03140726 0.03175898
## [73,] 0.034232057 0.03560113 0.03562841
## [74,] 0.045969836 0.04617217 0.04618249
## [75,] 0.024009820 0.02430284 0.02621934
## [76,] 0.046688621 0.04737807 0.04807382
## [77,] 0.027401235 0.02810414 0.02823760
## [78,] 0.022136097 0.02332162 0.02539391
## [79,] 0.029014153 0.02979425 0.03032987
## [80,] 0.019047632 0.02069425 0.02142327
## [81,] 0.054161128 0.05546015 0.05586986
## [82,] 0.018372780 0.01840513 0.01963240
## [83,] 0.037393845 0.03760705 0.04115078
## [84,] 0.027171170 0.02841007 0.02867445
## [85,] 0.027531100 0.02805119 0.02910978
## [86,] 0.034203311 0.03429324 0.03624937

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```

## [87,] 0.027226030 0.02794455 0.02973075
## [88,] 0.024212655 0.02547092 0.02571165
## [89,] 0.029512813 0.02952355 0.03095823
## [90,] 0.031281310 0.03139183 0.03410459
## [91,] 0.024796334 0.02528663 0.02700941
## [92,] 0.041529826 0.04398251 0.04568481
## [93,] 0.031775236 0.03368414 0.03408861
## [94,] 0.053177040 0.05336327 0.05898072
## [95,] 0.055758565 0.05691710 0.05722905
## [96,] 0.072904543 0.07311303 0.07600557
## [97,] 0.031695457 0.03295674 0.03464918
## [98,] 0.041825337 0.04353069 0.04469150
## [99,] 0.036161398 0.03658930 0.03693784
## [100,] 0.025083862 0.02719887 0.02808631
## [101,] 0.034099287 0.03439065 0.04037663
## [102,] 0.035043650 0.03507966 0.03708888
## [103,] 0.024487146 0.02608967 0.02847276
## [104,] 0.030430530 0.03140232 0.03213717
## [105,] 0.027099567 0.03255594 0.03297970
## [106,] 0.048691322 0.05185971 0.05308535
## [107,] 0.072431166 0.07512984 0.07544524
## [108,] 0.023905732 0.02447057 0.02538538
## [109,] 0.031259530 0.03253859 0.03817783
## [110,] 0.046047182 0.04605337 0.04712003
## [111,] 0.041076816 0.04162694 0.04392183
## [112,] 0.060202262 0.06125145 0.06374289
## [113,] 0.045884448 0.04909200 0.05057938
## [114,] 0.045443031 0.04800690 0.04863240
## [115,] 0.051353017 0.05199076 0.05283629
## [116,] 0.054687850 0.05726035 0.05847902
## [117,] 0.047409209 0.05343704 0.05915302
## [118,] 0.049478128 0.04962191 0.05010243
## [119,] 0.054398951 0.05447458 0.05468494
## [120,] 0.081639006 0.08219450 0.08380627
## [121,] 0.034145305 0.03444382 0.03524126
## [122,] 0.043957628 0.04435382 0.04455946
## [123,] 0.038591949 0.04198902 0.04315126
## [124,] 0.038023337 0.03988099 0.04005503
## [125,] 0.068886695 0.06940802 0.07139050
## [126,] 0.056047024 0.05849509 0.05856714
## [127,] 0.037539155 0.04043736 0.04046887
## [128,] 0.032948923 0.03511359 0.03542068
## [129,] 0.033814022 0.03528038 0.03640691
## [130,] 0.053647884 0.05378811 0.05409691
## [131,] 0.035986592 0.03604653 0.03935384
## [132,] 0.077468760 0.07795259 0.07798998
## [133,] 0.060419132 0.06225787 0.06257067
## [134,] 0.049665772 0.05283037 0.05405462
## [135,] 0.045935245 0.04695957 0.05166994
## [136,] 0.058768763 0.06483132 0.06634695
## [137,] 0.046999826 0.04842865 0.04990911
## [138,] 0.075318052 0.07840861 0.08050195
## [139,] 0.059901889 0.06287332 0.06294561
## [140,] 0.032244652 0.03237021 0.03378544

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```

## [141,] 0.043569638 0.04405516 0.04469713
## [142,] 0.019578264 0.02029494 0.02032517
## [143,] 0.036491439 0.03725131 0.03831606
## [144,] 0.020679275 0.02072507 0.02089882
## [145,] 0.022361707 0.02313549 0.02394918
## [146,] 0.024172319 0.02446840 0.02457645
## [147,] 0.048073509 0.04824557 0.04844807
## [148,] 0.026713497 0.03067914 0.03116069
## [149,] 0.024773130 0.02491605 0.02658128
## [150,] 0.021791030 0.02206085 0.02237368
## [151,] 0.017365586 0.01821453 0.02053456
## [152,] 0.060151668 0.06058042 0.06078106
## [153,] 0.046080752 0.04734792 0.05003542
## [154,] 0.039175553 0.04313355 0.04350143
## [155,] 0.049545501 0.04993805 0.05026212
## [156,] 0.053832849 0.05671623 0.05962102
## [157,] 0.063873313 0.06501497 0.06623030
## [158,] 0.043643638 0.04389231 0.05080616
## [159,] 0.049240976 0.04937310 0.05018656
## [160,] 0.050861901 0.05225275 0.05244531
## [161,] 0.048141423 0.04834974 0.05023908
## [162,] 0.061681275 0.06300075 0.06335617
## [163,] 0.073756900 0.07391942 0.07464122
## [164,] 0.041184179 0.04239534 0.04264727
## [165,] 0.045570157 0.04685371 0.04690521
## [166,] 0.049269602 0.05189671 0.05193704
## [167,] 0.034207196 0.03451315 0.03473231
## [168,] 0.043237065 0.04431049 0.04531261
## [169,] 0.032644524 0.03344845 0.03502925
## [170,] 0.049524598 0.04988492 0.05034937
## [171,] 0.035537948 0.03609835 0.03760649
## [172,] 0.040673375 0.04128275 0.04196515
## [173,] 0.052441351 0.05261616 0.05350882
## [174,] 0.035211222 0.03544681 0.03560094
## [175,] 0.014648956 0.01556484 0.01584350
## [176,] 0.015906774 0.01695757 0.01713483
## [177,] 0.026072461 0.02619585 0.02632608
## [178,] 0.020249431 0.02037176 0.02263270
## [179,] 0.030299687 0.03037695 0.03082746
## [180,] 0.027461211 0.02761537 0.02797003
## [181,] 0.021063602 0.02177913 0.02259844
## [182,] 0.021459779 0.02238496 0.02242404
## [183,] 0.020939463 0.02132472 0.02222777
## [184,] 0.015229489 0.01825378 0.01846703
## [185,] 0.017311923 0.01906433 0.01995445
## [186,] 0.028298958 0.02960941 0.03021926
## [187,] 0.022763898 0.02368754 0.02389861
## [188,] 0.022774524 0.02280648 0.02389027
## [189,] 0.035916741 0.03690247 0.03873982
## [190,] 0.018684451 0.01880571 0.01938034
## [191,] 0.021597692 0.02252479 0.02425943
## [192,] 0.048892131 0.04889744 0.04922881
## [193,] 0.068852470 0.06990505 0.06997159
## [194,] 0.077501086 0.07964056 0.08021041

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```

## [195,] 0.021968901 0.02323549 0.02369754
## [196,] 0.023949075 0.02460860 0.02555682
## [197,] 0.026565438 0.03128728 0.03150671
## [198,] 0.043709578 0.04415302 0.04505540
## [199,] 0.025087710 0.02534883 0.02657279
## [200,] 0.025532246 0.02562867 0.02575938
## [201,] 0.027740869 0.02815989 0.02964968
## [202,] 0.013155149 0.01366652 0.01368065
## [203,] 0.017996806 0.01811253 0.01891320
## [204,] 0.017478484 0.01750532 0.01976471
## [205,] 0.010997113 0.01197059 0.01282132
## [206,] 0.021777240 0.02286793 0.02409932
## [207,] 0.014579382 0.01462652 0.01484790
## [208,] 0.011341012 0.01205751 0.01278904
## [209,] 0.017644885 0.01791002 0.01942292
## [210,] 0.015683438 0.01575812 0.01609940
## [211,] 0.016236584 0.01624192 0.01685163
## [212,] 0.014254223 0.01430342 0.01495912
## [213,] 0.010702470 0.01172352 0.01182032
## [214,] 0.016909329 0.01737236 0.01835798
## [215,] 0.011869828 0.01284024 0.01298235
## [216,] 0.022446371 0.02399021 0.02402359
## [217,] 0.013139322 0.01505529 0.01515872
## [218,] 0.029102179 0.02949760 0.03231294
## [219,] 0.062195872 0.06307326 0.06587493
## [220,] 0.037864030 0.03877822 0.04167504
## [221,] 0.033605441 0.03580512 0.03749260
## [222,] 0.028764590 0.02908005 0.02925477
## [223,] 0.026929097 0.02694575 0.02712712
## [224,] 0.029217735 0.03203425 0.03235718
## [225,] 0.127755796 0.12876194 0.13151281
## [226,] 0.075877387 0.07984266 0.09087387
## [227,] 0.099931399 0.10674995 0.10973933
## [228,] 0.099837929 0.10413962 0.11393266
## [229,] 0.139262884 0.15046798 0.15248345
## [230,] 0.082544916 0.09193799 0.10767081
## [231,] 0.111786347 0.11298768 0.12320857
## [232,] 0.090834731 0.09732859 0.10482929
## [233,] 0.129656058 0.13436984 0.13811464
## [234,] 0.089452091 0.09819813 0.09969405
## [235,] 0.048263283 0.04897581 0.05186446
## [236,] 0.027150967 0.02744164 0.02759158
## [237,] 0.042532277 0.04520547 0.04598946
## [238,] 0.026979770 0.02855262 0.02921448
## [239,] 0.061323003 0.06199464 0.06204844
## [240,] 0.054086163 0.05505694 0.05614734
## [241,] 0.030254517 0.03070607 0.03207859
## [242,] 0.054336605 0.05514989 0.06009364
## [243,] 0.039516151 0.03962956 0.04179158
## [244,] 0.068263265 0.06904135 0.07203065
## [245,] 0.020351950 0.02035701 0.02158275
## [246,] 0.050016623 0.05014631 0.05088460
## [247,] 0.037707564 0.03875505 0.03967038
## [248,] 0.035515576 0.03597519 0.03680121

```



```

## [249,] 0.034673906 0.03556651 0.03626036
## [250,] 0.019526355 0.01956483 0.02040705
## [251,] 0.022962769 0.02432993 0.02513756
## [252,] 0.032606417 0.03321899 0.03359362
## [253,] 0.029128430 0.02946409 0.03011933
## [254,] 0.025357057 0.02635299 0.02670163
## [255,] 0.038753648 0.03938619 0.03992400
## [256,] 0.022771062 0.02280764 0.02301311
## [257,] 0.023689842 0.02506840 0.02973300
## [258,] 0.040379739 0.04050354 0.04096404
## [259,] 0.042271958 0.04811261 0.05051891
## [260,] 0.023160660 0.02322831 0.02353529
## [261,] 0.079067848 0.07981693 0.08019656
## [262,] 0.011090501 0.01230544 0.01445881
## [263,] 0.021734380 0.02209793 0.02215286
## [264,] 0.011580336 0.01217510 0.01290258
## [265,] 0.016830184 0.01742270 0.01773516
## [266,] 0.020205921 0.02119074 0.02120338
## [267,] 0.009925782 0.01013603 0.01017341
## [268,] 0.026077952 0.02643538 0.02652267
## [269,] 0.016280469 0.01692154 0.01745557
## [270,] 0.020467900 0.02051415 0.02070207
## [271,] 0.015077181 0.01540872 0.01544836
## [272,] 0.046501895 0.04723884 0.04858508
## [273,] 0.054485880 0.05519651 0.05612699
## [274,] 0.039145945 0.04067566 0.04107377
## [275,] 0.038954068 0.03925783 0.03958293
## [276,] 0.040051200 0.04153771 0.04474301
## [277,] 0.038203420 0.03927809 0.03999240
## [278,] 0.048554719 0.04966464 0.05137669
## [279,] 0.033777888 0.03386953 0.03745526
## [280,] 0.038055818 0.03966751 0.04069835
## [281,] 0.036217429 0.03652814 0.03679994
## [282,] 0.048273524 0.04879352 0.04989885
## [283,] 0.060201669 0.06027645 0.06064136
## [284,] 0.043152277 0.04352603 0.04545207
## [285,] 0.036876781 0.03863434 0.03864035
## [286,] 0.061532576 0.06338782 0.06586013
## [287,] 0.052013193 0.05776218 0.05840443
## [288,] 0.064132425 0.06653128 0.06863914
## [289,] 0.060048377 0.06481792 0.06600586
## [290,] 0.104657573 0.10499903 0.11717789
## [291,] 0.072772035 0.07607869 0.07714623
## [292,] 0.052167364 0.06112307 0.06642304
## [293,] 0.077585802 0.07880725 0.08031415
## [294,] 0.056083383 0.05743005 0.06036141
## [295,] 0.090137054 0.09022108 0.09345066
## [296,] 0.055533323 0.05688516 0.06422283
## [297,] 0.077593549 0.07816767 0.07826808
## [298,] 0.082598241 0.08338803 0.08527831
## [299,] 0.077413654 0.08088921 0.08122504
## [300,] 0.109400596 0.11271243 0.11526285
## 198 Levels: -0.0014944306396889 -0.626121741531422 ... 97.9035109586548

```

```
binary25<- knn(train, test,cl=target_category, k=25)
binary25
```

```
## [1] 67.2462258192531 66.2613534945978 67.1394721380322
## [4] 65.7799426366212 65.7799426366212 67.2082831025027
## [7] 62.0236510691809 45.0622846424644 45.8835255714033
## [10] 45.8835255714033 45.0557880243366 45.0557880243366
## [13] 38.8147979990146 41.7604501219249 41.1729602146182
## [16] 41.9533294088145 38.8147979990146 42.0583282978465
## [19] 40.961792439184 41.7604501219249 42.4761666858862
## [22] 41.9533294088145 38.6303670827825 41.7604501219249
## [25] 39.4246994789974 90.4249756131192 90.4249756131192
## [28] 87.5951564476289 92.8914066509878 92.8914066509878
## [31] 90.8873122328356 93.401927840133 90.4249756131192
## [34] 92.8914066509878 4.9841639060768 8.2210665115028
## [37] 7.95578845765198 12.1172171968014 5.65833720741339
## [40] 7.92072846265277 11.3815097991607 10.77938098843
## [43] 55.416979526897 57.3923325604887 42.0251373958012
## [46] 44.7688454832637 42.0251373958012 31.738680231249
## [49] 39.4717128259236 40.6549781387099 41.1624693211597
## [52] 42.0251373958012 0.0566420864278663 8.16318993454417
## [55] 5.26315040819022 8.77596447364277 7.58091983282684
## [58] -0.626121741531422 8.73646435691878 5.77847412979777
## [61] 5.10927056478779 9.16841873469325 7.03828507933107
## [64] 6.15371885983455 85.4679532807631 86.6896530283807
## [67] 83.9080978224609 83.9080978224609 85.4679532807631
## [70] 85.6074127168744 85.4679532807631 85.4679532807631
## [73] 85.4679532807631 83.9080978224609 20.7776255890691
## [76] 10.5603988195599 22.3400763210097 22.0782249867995
## [79] 23.8631100845223 20.2182759361716 11.2636643909429
## [82] 20.2182759361716 25.4795506929641 22.6631431765923
## [85] -0.0014944306396889 2.85849132257661 -1.0497112989491
## [88] 0.708282895189088 -3.07239408639785 2.55070713929827
## [91] 0.708282895189088 -5.20049618173059 -0.0014944306396889
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##	[164,]	657	675	966	821	741	496	737	1145	1055	901	776	350	833

## [165,]	117	267	45	936	195	437	201	688	104	587	653	460	597
## [166,]	460	104	339	570	437	127	936	207	46	117	666	688	930
## [167,]	688	597	666	46	222	830	109	728	195	437	72	267	117
## [168,]	587	1132	670	429	195	830	589	1038	330	72	730	45	320
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## [171,]	597	688	222	666	46	728	109	454	693	830	930	207	72
## [172,]	207	570	930	339	46	666	460	693	728	104	454	986	688
## [173,]	460	339	104	127	570	437	936	207	1000	46	117	666	889
## [174,]	144	1153	748	381	549	314	716	334	797	447	76	1002	690
## [175,]	916	1006	555	172	594	351	317	949	510	233	1028	308	902
## [176,]	916	555	1006	594	172	949	351	233	510	317	902	308	1028
## [177,]	277	296	557	91	1050	1164	846	547	844	317	385	852	727
## [178,]	727	846	91	852	907	547	26	844	874	277	510	296	317
## [179,]	447	690	716	76	314	767	1037	459	1153	381	1002	280	256
## [180,]	732	295	902	215	949	308	35	351	1150	594	233	916	334
## [181,]	334	549	381	1002	314	308	256	1028	716	1153	351	1109	259
## [182,]	76	1037	1002	314	716	256	690	1109	259	381	61	447	334
## [183,]	949	233	215	902	362	555	510	916	874	594	308	1006	351
## [184,]	955	259	1109	1028	172	256	1006	594	61	351	916	1002	1050
## [185,]	955	61	1109	259	256	1028	280	385	1002	172	1037	1050	1006
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## [193,]	1128	801	63	702	859	370	325	186	73	360	620	489	1032
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## [202,]	998	342	211	257	643	898	705	1040	379	337	1078	353	173
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## [239,]	1008	576	678	212	435	1152	126	772	869	768	1189	638	387
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## [272,]	834	691	837	585	383	855	851	142	1052	417	372	412	1125


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##	[38,]	906	521	786	967	22	783	658	1034	469	674	606	756
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##	[43,]	247	953	112	613	411	973	241	1124	838	578	312	366
##	[44,]	363	208	128	371	1177	541	565	616	413	1070	771	578
##	[45,]	321	911	1090	1024	525	166	692	333	488	665	1021	632
##	[46,]	464	1090	854	209	920	870	964	31	725	911	544	377
##	[47,]	911	321	1090	333	488	632	692	1024	525	166	725	13
##	[48,]	736	384	533	57	406	359	245	983	1014	567	505	1179
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##	[52,]	1021	665	692	703	911	1090	321	632	1024	166	333	488
##	[53,]	637	181	463	349	62	1190	477	292	593	781	684	812
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##	[67,]	341	165	723	398	171	485	564	474	282	826	324	1009
##	[68,]	485	398	474	324	282	515	1075	171	165	826	471	168
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[247,] 0.04261589 0.04295071

```

## [248,] 0.03888385 0.03890975
## [249,] 0.03853891 0.03891161
## [250,] 0.02312223 0.02327276
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## [259,] 0.05634019 0.05742420
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## [265,] 0.01927314 0.02059810
## [266,] 0.02254616 0.02370636
## [267,] 0.01326133 0.01341426
## [268,] 0.02895224 0.03006373
## [269,] 0.01947220 0.01973381
## [270,] 0.02369760 0.02373329
## [271,] 0.01771570 0.01830472
## [272,] 0.05129713 0.05198445
## [273,] 0.06020101 0.06050109
## [274,] 0.04601768 0.04700523
## [275,] 0.04194652 0.04211511
## [276,] 0.05219992 0.05225321
## [277,] 0.04815092 0.05016016
## [278,] 0.06040712 0.06271592
## [279,] 0.04458687 0.04720299
## [280,] 0.04891374 0.04987335
## [281,] 0.04019993 0.04122853
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## [283,] 0.06992588 0.07043912
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## [285,] 0.04224595 0.04321440
## [286,] 0.06843752 0.07051099
## [287,] 0.06851899 0.08238332
## [288,] 0.09043797 0.09279856
## [289,] 0.08087165 0.09025535
## [290,] 0.13751459 0.14551262
## [291,] 0.09817204 0.10071359
## [292,] 0.07316096 0.07766588
## [293,] 0.09121366 0.09493432
## [294,] 0.06654314 0.08244543
## [295,] 0.09846248 0.10031475
## [296,] 0.06897548 0.06947690
## [297,] 0.08933287 0.09267215
## [298,] 0.10540030 0.10610763
## [299,] 0.09788675 0.10180652
## [300,] 0.12637591 0.13533668
## 189 Levels: -0.0014944306396889 -0.626121741531422 ... 97.6559951334489

```

```
tri_norm <- as.data.frame(lapply(trinary_df[,c(2:3)],normalize))
head(tri_norm)
```

```
##           x           y
## 1 0.3395560 0.3890216
## 2 0.3495902 0.5037685
## 3 0.3735363 0.4801528
## 4 0.3605825 0.4041591
## 5 0.3779910 0.4442837
## 6 0.3708747 0.4326334
```

```
data_split <- sample(1:nrow(tri_norm), .8 * nrow(tri_norm))
train2<- tri_norm[data_split,]
head(train2)
```

```
##           x           y
## 694 0.6347831 0.6687908
## 272 0.7259032 0.9910419
## 1206 0.1498426 0.6087777
## 550 0.8996763 0.5041450
## 1172 0.1337753 0.7048625
## 1313 0.8705181 0.3884197
```

```
dim(train2)
```

```
## [1] 1254    2
```

```
test2<- tri_norm[-data_split,]
```

```
target_category1<-trinary_df[data_split, 3]
test_category1<- trinary_df[-data_split, 3]
```

```
target_category1
```

```
##      [1] 69.240141 103.345391 62.888694 51.814949 73.057769 39.567233
##      [7] 37.754047 28.773203 57.076384 50.699562 100.010052 86.839072
##     [13] 76.580891 78.965263 84.941993 38.843626 33.303278 93.010012
##     [19] 34.333285 103.322681 43.492759 34.670889 76.663449 42.038313
##     [25] 51.037486 35.024639 38.031059 36.187598 42.980379 100.505503
##     [31] 52.135525 47.806793 90.970133 70.856932 60.168046 13.480576
##     [37] 92.178050 26.210823 75.290332 41.036618 11.685083 37.374005
##     [43] 90.576197 58.842614 45.479562 79.876709 5.462282 56.136017
##     [49] 67.513684 86.776540 99.022043 65.447603 55.863006 56.730185
##     [55] 33.281560 100.784891 32.034665 59.126810 91.544616 35.368422
##     [61] 82.106038 65.725983 19.362451 47.737517 37.425069 11.841524
##     [67] 71.211779 54.346531 22.583180 95.733376 68.568434 86.600655
##     [73] 85.751076 68.317205 55.749800 40.129769 39.591798 39.862382
##     [79] 87.432597 63.316571 87.228523 48.683457 74.130459 57.455887
##     [85] 78.584983 57.196438 85.184715 95.285834 57.086686 59.685812
##     [91] 47.398074 35.760281 85.953887 35.389963 90.623660 90.099488
##     [97] 41.731617 34.483937 18.010644 62.025516 35.943845 88.606803
```

##	[103]	34.277428	31.939170	44.779776	85.826048	57.605783	33.405189
##	[109]	84.181756	98.165917	35.093793	93.686075	39.630936	91.820555
##	[115]	59.243904	34.129445	86.674237	32.735558	41.212990	5.536424
##	[121]	76.478783	75.613478	87.515905	42.666931	60.154623	61.890727
##	[127]	91.699895	54.099144	82.468100	61.145272	33.885209	81.517862
##	[133]	50.618256	38.942695	35.078133	56.180690	83.155997	34.419501
##	[139]	16.865827	36.651013	17.296961	33.768818	38.599055	93.056185
##	[145]	58.666948	65.433509	44.834219	38.377223	98.765822	94.169879
##	[151]	41.730941	49.483799	37.926243	69.457812	95.211815	72.511995
##	[157]	50.461705	93.412748	41.907037	11.638243	66.421249	50.943574
##	[163]	58.863282	79.395067	57.498667	11.943523	81.483220	84.633728
##	[169]	36.634507	56.394971	18.357001	66.588738	54.584311	8.073557
##	[175]	71.041922	89.383169	77.092025	93.973475	93.115263	37.261262
##	[181]	68.628246	90.081700	81.374417	29.678732	90.304199	43.562081
##	[187]	37.664600	27.175934	18.870059	88.747187	36.120458	37.252233
##	[193]	17.019368	42.131451	38.623562	15.892859	34.068236	10.708888
##	[199]	40.156843	73.085422	48.629811	36.056447	83.440684	14.638738
##	[205]	87.857816	42.433121	39.195414	57.109781	56.228216	85.782648
##	[211]	93.058657	67.336466	33.571439	6.464906	99.826451	71.113154
##	[217]	86.625559	59.288308	52.710374	59.289454	8.236265	37.133438
##	[223]	76.908854	34.356944	32.634289	42.006745	40.987387	35.219470
##	[229]	67.946658	57.642812	59.548766	88.515590	90.564881	-1.540938
##	[235]	75.031428	79.404051	87.994402	90.819015	11.433070	79.310196
##	[241]	34.292897	85.776360	33.687695	60.089625	56.259080	95.873880
##	[247]	28.268546	15.599057	62.070846	70.772026	41.599298	98.629671
##	[253]	56.086152	24.418715	56.692336	80.447982	39.501590	38.001920
##	[259]	98.803851	87.127939	73.846521	45.514532	15.238014	33.549667
##	[265]	15.474540	67.453318	63.806646	53.355366	45.097064	46.293054
##	[271]	69.579867	101.042103	34.118775	72.095528	7.231187	37.007752
##	[277]	65.984948	98.019448	39.889149	64.593469	61.332109	54.263847
##	[283]	89.607027	57.857701	45.504596	34.115632	58.778596	73.175777
##	[289]	56.378192	12.402610	20.328189	19.763181	13.873831	86.849833
##	[295]	63.112403	72.765955	18.477395	19.832853	74.650684	31.248901
##	[301]	76.204269	84.722347	42.708249	14.955564	56.364568	82.674244
##	[307]	61.681106	90.255672	76.944471	46.070989	100.522480	73.825419
##	[313]	95.408290	70.046255	92.372857	54.578228	85.813042	43.656448
##	[319]	36.405683	59.266664	33.743708	83.151673	47.761488	28.284893
##	[325]	29.626945	69.422358	44.531736	76.615036	69.137028	33.415388
##	[331]	55.757754	77.734497	59.611240	43.088815	56.184698	90.078715
##	[337]	50.237507	101.723810	68.971575	40.071302	76.366049	48.273396
##	[343]	69.123150	73.185489	35.151837	79.649093	98.260578	33.460695
##	[349]	79.857229	91.924279	82.723480	12.323731	59.545743	29.727720
##	[355]	35.192789	58.639688	17.805354	60.554095	41.272049	57.491155
##	[361]	96.933186	31.290043	36.824955	33.625991	56.149028	16.474371
##	[367]	41.823334	38.038372	32.974955	83.536201	45.032876	61.125657
##	[373]	37.264515	43.904637	13.164055	34.717227	17.762513	72.208611
##	[379]	67.684456	62.043209	60.199142	33.286800	78.800946	39.998152
##	[385]	77.692953	100.826438	50.120320	78.854075	16.267853	56.787413
##	[391]	93.529577	50.398625	82.851491	42.332122	42.386119	42.250169
##	[397]	25.181065	83.077418	98.491395	92.006439	36.402205	56.845363
##	[403]	85.656344	16.129142	67.021035	46.881558	85.816713	63.826626
##	[409]	32.255401	23.729956	59.700454	71.263991	59.446026	30.254965
##	[415]	44.791583	15.690899	33.811092	53.212550	51.775107	40.949956
##	[421]	42.210368	2.998417	52.166378	34.674837	59.385584	62.042286

##	[427]	71.200033	88.962876	40.538387	35.942303	28.442800	69.777519
##	[433]	14.730488	70.380718	87.006535	78.566416	46.951782	53.449028
##	[439]	95.586808	79.805511	49.499471	70.239647	81.771769	62.201730
##	[445]	13.850407	69.054444	71.449788	71.688206	90.766535	16.182508
##	[451]	61.446397	21.113225	70.975611	97.576774	100.563929	35.873190
##	[457]	47.361731	33.250458	84.860747	89.726229	35.915479	42.944171
##	[463]	58.973528	35.724671	73.355669	39.175088	51.407288	91.589721
##	[469]	38.000750	18.694493	12.634745	48.307305	59.633014	34.282776
##	[475]	39.203060	64.451546	17.266696	42.430856	41.232997	75.752008
##	[481]	80.054119	6.664916	52.924536	83.779730	15.922493	91.369469
##	[487]	73.022429	58.583250	98.928928	91.629207	29.617355	59.989136
##	[493]	37.664797	63.981527	58.541392	20.754105	94.176722	66.126974
##	[499]	8.175388	43.660011	35.328365	5.482853	70.969397	62.741017
##	[505]	69.620661	57.208240	86.795025	91.033729	50.230164	33.219064
##	[511]	33.558980	39.160583	73.070698	13.990149	85.308904	7.695630
##	[517]	69.889538	37.104936	34.777602	100.160367	70.600875	89.740536
##	[523]	46.060302	85.330502	53.611859	85.615325	61.127194	57.172747
##	[529]	48.139217	83.437346	31.491017	50.636676	59.309554	38.929829
##	[535]	101.021872	34.536182	21.293391	70.683085	84.660786	96.784031
##	[541]	98.498999	37.586262	63.138338	40.804563	37.401881	38.906384
##	[547]	39.110610	32.189897	35.142248	77.306867	88.138361	33.769305
##	[553]	41.570903	87.270416	87.541281	11.218522	17.007789	15.361944
##	[559]	83.300057	54.384629	67.252797	68.785213	53.282133	88.035522
##	[565]	38.276536	42.819605	41.858126	5.069794	60.680893	38.693971
##	[571]	73.479958	56.127389	100.262190	67.931386	76.636825	60.397344
##	[577]	82.883967	53.450500	17.260321	92.101581	41.914315	87.567461
##	[583]	36.834952	57.319854	38.017568	90.695772	66.615305	87.555646
##	[589]	17.617123	38.802154	98.509952	31.822607	98.183404	90.845803
##	[595]	93.649597	68.190163	20.741992	55.664649	14.076098	33.814723
##	[601]	32.002805	68.014791	41.917450	49.910546	18.243519	74.761306
##	[607]	45.716756	88.373579	36.981613	59.158706	91.715739	66.222219
##	[613]	41.889692	36.325088	68.628179	36.500673	88.057115	82.030847
##	[619]	67.659155	94.496172	89.320157	32.296815	74.870897	34.485728
##	[625]	68.546032	58.572823	15.460982	17.903569	74.770299	49.056807
##	[631]	42.675672	88.048510	42.858045	80.430439	43.743900	35.501755
##	[637]	43.162917	82.192232	41.846341	76.500486	37.715777	71.938941
##	[643]	83.918501	53.550013	41.192561	16.365583	5.832125	36.890967
##	[649]	71.095273	50.884333	18.054488	5.762952	50.378795	53.141669
##	[655]	99.655472	10.368543	60.211220	9.851227	60.231073	32.493974
##	[661]	43.567845	61.173788	92.325947	88.863569	15.638991	42.856086
##	[667]	39.557599	53.125435	81.732673	79.042597	13.583793	69.174492
##	[673]	88.649952	44.941228	85.224112	33.227733	39.684220	17.170116
##	[679]	56.772471	21.949657	34.660916	81.726590	103.315874	12.361693
##	[685]	18.435013	92.763316	84.064876	58.615326	83.662482	49.402117
##	[691]	58.223928	74.342443	90.403727	57.991029	35.649421	6.734168
##	[697]	72.164560	40.653953	54.833157	77.223471	6.141259	41.106721
##	[703]	84.691559	68.456969	90.433969	94.888908	95.205383	36.824057
##	[709]	68.216646	39.294827	55.609664	92.962994	6.664482	37.976899
##	[715]	91.947370	38.818729	13.952066	18.291455	27.261071	58.374454
##	[721]	44.760091	23.819000	33.531047	55.159307	88.603116	90.604044
##	[727]	46.231494	42.263021	33.682870	41.872136	42.118202	57.692007
##	[733]	71.122222	43.205434	68.643031	36.233617	34.753571	16.275938
##	[739]	40.793506	18.193355	17.145821	52.589936	86.463793	93.194967
##	[745]	86.644634	88.414713	54.522153	66.015741	35.265535	91.951135

##	[751]	55.706894	82.510477	57.717838	67.538017	81.062520	36.823452
##	[757]	99.944387	73.886726	56.653225	60.201533	89.645788	59.446230
##	[763]	42.998134	49.275748	49.012734	42.257596	48.063002	67.012676
##	[769]	39.008713	31.731191	18.720964	43.667103	79.000058	53.282249
##	[775]	44.283658	58.326958	34.944484	42.852687	86.720937	35.259523
##	[781]	92.105603	82.737698	36.967283	15.734158	56.450370	43.116210
##	[787]	89.588822	18.210288	34.556619	65.783823	79.391632	52.070533
##	[793]	17.403641	10.203669	58.364988	67.608510	35.798248	35.923992
##	[799]	20.862716	36.056355	92.429162	14.486605	78.631302	75.601492
##	[805]	34.704588	84.076000	88.327799	39.868198	93.203960	60.327925
##	[811]	36.165580	59.686367	72.193948	34.731744	34.339258	91.638696
##	[817]	13.023018	90.142206	18.732539	99.828276	92.491367	58.400154
##	[823]	36.350142	80.650998	102.054916	18.602095	42.147761	6.236151
##	[829]	60.462683	81.608903	66.975061	95.181662	13.978497	82.702905
##	[835]	5.200106	89.160893	64.060049	37.959017	60.161671	39.805936
##	[841]	91.684780	62.725526	47.687744	35.709156	67.996863	98.010408
##	[847]	95.113064	67.268706	43.314987	32.997919	33.839627	84.217603
##	[853]	57.040824	83.415980	87.087550	35.878373	15.417706	15.392359
##	[859]	89.160327	71.079406	85.388054	16.216117	42.531588	16.349050
##	[865]	83.079598	84.112590	38.823961	32.531749	13.580567	82.255318
##	[871]	29.042448	97.554543	83.558742	72.539844	74.461440	28.236401
##	[877]	17.195680	17.989603	18.066314	10.189044	75.851719	50.790234
##	[883]	49.976163	79.451331	40.051076	16.920564	59.595714	70.996595
##	[889]	40.702892	37.146102	74.606156	70.673349	17.478333	84.987409
##	[895]	30.067263	79.651289	76.560476	6.204033	80.536246	34.106777
##	[901]	91.737676	93.407707	69.521988	82.678125	84.745367	84.661500
##	[907]	37.370098	54.264929	76.045712	60.220041	12.201949	92.595826
##	[913]	45.678528	89.760254	35.636814	36.131972	99.254171	100.166025
##	[919]	40.963634	91.953037	92.100058	96.544456	28.897504	58.935120
##	[925]	81.325604	69.701207	33.013617	83.769080	73.957803	90.460655
##	[931]	12.492531	37.528515	91.593389	75.836234	14.521905	56.859337
##	[937]	35.084708	45.381147	55.695519	53.296752	87.342848	97.764541
##	[943]	64.112255	14.004833	81.783037	17.867582	84.061227	70.228401
##	[949]	62.486842	40.968492	72.923824	63.363765	87.132228	76.434003
##	[955]	35.467597	82.349645	44.746419	38.112318	42.464402	89.852226
##	[961]	72.188729	18.009200	92.484772	48.623018	14.659319	85.732883
##	[967]	35.703443	36.861170	14.664162	82.168264	20.460588	92.946120
##	[973]	71.031059	92.464018	15.341779	63.820380	34.600601	43.225655
##	[979]	100.026020	94.554409	91.419105	76.054151	91.447947	78.264332
##	[985]	43.070883	81.535939	43.621867	48.614589	66.835986	33.745081
##	[991]	55.854366	60.477614	32.548818	72.817957	4.307283	31.609759
##	[997]	13.216271	81.605656	87.543339	99.534483	43.467760	81.498317
##	[1003]	97.450543	61.554645	84.494661	76.784131	44.200374	19.008041
##	[1009]	81.075748	80.210372	80.462954	41.780159	34.657093	51.243207
##	[1015]	80.357581	80.328936	44.094350	94.396343	16.946686	70.648659
##	[1021]	92.847875	43.640779	92.406502	99.404258	85.926025	100.304910
##	[1027]	85.223879	11.723383	82.830234	52.306806	88.125271	6.835447
##	[1033]	47.876798	98.606073	99.975232	46.475059	35.147499	52.971362
##	[1039]	74.211338	32.916590	58.575291	35.152467	67.381562	14.592080
##	[1045]	42.591679	15.008209	5.643818	87.765888	55.631060	51.849608
##	[1051]	58.310299	14.363831	42.948667	8.363287	37.713223	36.332045
##	[1057]	42.836492	86.657084	87.211965	35.539457	85.610290	21.956496
##	[1063]	31.026682	34.076594	5.453453	59.191339	14.495805	36.623044
##	[1069]	69.692828	57.141730	47.937106	39.814439	58.308741	35.388112

##	[1075]	31.984327	41.401362	58.045002	84.976254	71.134388	50.881395
##	[1081]	69.603920	17.210203	52.745902	89.970934	29.929717	92.360466
##	[1087]	70.538402	16.952113	69.426656	83.310908	80.070523	31.981059
##	[1093]	45.108358	91.128028	30.838923	42.604030	75.876402	35.263061
##	[1099]	65.777438	24.117700	17.031120	31.519745	76.965000	63.501757
##	[1105]	58.639912	82.831641	3.641800	87.996502	76.592610	33.183626
##	[1111]	67.020786	34.795654	45.380421	14.439260	77.278503	51.649676
##	[1117]	58.608748	53.496135	75.308582	53.947749	81.887161	35.649596
##	[1123]	40.858538	34.991962	89.606343	78.242802	31.904546	59.049968
##	[1129]	87.820731	76.963991	23.828587	62.072820	55.350726	84.681355
##	[1135]	14.428642	103.254728	47.002403	45.778240	63.604426	37.007804
##	[1141]	85.824715	84.816603	48.504042	41.908344	59.891146	33.911591
##	[1147]	91.229665	78.292790	83.157984	75.784459	50.411894	44.172496
##	[1153]	73.824384	58.379801	19.561965	46.618227	59.277195	64.085046
##	[1159]	70.320718	86.394119	54.986248	33.301970	36.774094	48.417927
##	[1165]	7.807092	40.110591	17.080049	7.662129	36.368289	38.866010
##	[1171]	63.948534	43.791926	41.150461	82.152696	31.713345	35.273917
##	[1177]	83.795193	51.682404	70.898300	56.757742	65.376718	31.871789
##	[1183]	76.024971	85.570411	15.347409	56.727205	86.948400	90.418433
##	[1189]	76.169929	36.224502	82.036397	73.928304	93.685799	75.936456
##	[1195]	14.094202	58.260996	70.259674	54.946059	74.968989	60.647213
##	[1201]	40.823553	36.077861	34.706190	57.139636	102.063249	55.302705
##	[1207]	48.119743	50.994857	10.670001	90.007260	45.879257	94.327315
##	[1213]	16.243582	32.019664	85.173903	14.332895	62.310898	38.567864
##	[1219]	20.664624	14.408307	52.049796	57.384125	71.475973	60.587731
##	[1225]	98.369855	72.299379	2.996773	46.784820	42.737761	57.974425
##	[1231]	48.207867	74.741225	17.067713	96.888443	31.519852	32.565001
##	[1237]	91.043491	25.487908	84.877825	85.619260	6.426498	92.398666
##	[1243]	43.485333	42.057478	83.448868	9.676581	30.817735	29.133444
##	[1249]	73.755463	50.096161	83.076011	30.719674	51.458917	58.387540

test_category1

##	[1]	44.246561	51.265539	47.411524	49.419327	46.863797	47.832374
##	[7]	54.249319	48.219274	47.650357	51.587379	47.456114	37.170744
##	[13]	47.766536	31.221670	33.786117	33.059657	37.231609	36.355933
##	[19]	34.923448	33.683680	33.632703	37.064684	35.876944	34.343046
##	[25]	34.779484	32.988848	32.429389	34.318320	36.283159	35.477603
##	[31]	37.277320	94.381157	85.673641	87.998445	86.145998	83.512834
##	[37]	78.823591	75.270880	74.015879	77.051391	77.924397	74.532069
##	[43]	74.291424	75.670921	91.566715	102.297194	92.956350	99.697451
##	[49]	89.167944	94.050883	104.293471	62.760834	56.397227	55.470826
##	[55]	55.977445	59.213143	52.860401	62.606438	61.542416	58.684169
##	[61]	53.470265	50.464096	59.006034	56.305111	46.871148	46.335219
##	[67]	48.803764	46.294640	46.171032	47.573877	46.924429	42.814170
##	[73]	38.807202	37.255747	32.506969	39.619106	18.128036	21.115138
##	[79]	17.819865	12.487134	18.657470	13.334992	17.426302	12.906471
##	[85]	14.977785	17.412190	15.202741	11.265416	12.392111	19.299947
##	[91]	15.328684	14.357401	18.215328	15.658144	19.679409	56.428105
##	[97]	56.184519	60.079260	54.263186	56.069611	56.962839	56.331246
##	[103]	54.495070	58.410166	60.606970	41.726211	41.841638	42.355337
##	[109]	40.899814	40.964936	42.728755	41.720761	41.042580	39.919416
##	[115]	40.377789	42.123758	42.065042	36.935191	37.352454	34.750909
##	[121]	36.347023	38.566452	32.827082	35.530334	36.364337	37.061729

```
## [127] 35.186325 41.521325 36.603970 36.167035 37.156926 45.895622
## [133] 32.920375 46.453939 30.619226 39.359641 66.068294 65.060595
## [139] 73.282017 65.783548 68.391549 67.582342 67.994216 72.586981
## [145] 69.614205 68.560326 71.256897 68.658157 66.778619 66.594390
## [151] 70.224003 68.145944 67.852875 72.606512 70.955708 70.321167
## [157] 73.893867 73.719858 66.324131 56.991587 58.274442 56.227969
## [163] 60.889862 61.556284 58.322027 54.513976 58.879767 56.293486
## [169] 53.062869 86.274577 83.067539 82.660758 83.652448 89.176193
## [175] 86.771498 85.874273 88.287002 82.311462 91.057401 83.763147
## [181] 82.924523 86.158738 41.503386 35.140465 32.132800 46.255894
## [187] 37.149650 35.813871 40.626888 17.228792 17.199267 16.526696
## [193] 18.185786 13.461044 14.412254 15.036588 13.758271 16.145040
## [199] 12.582681 99.214682 100.186783 99.337188 100.706605 101.889264
## [205] 99.661008 99.037696 97.863024 84.800531 88.914081 92.347639
## [211] 85.136533 89.728938 89.613267 85.728272 89.672500 90.197568
## [217] 92.258038 91.368411 91.727040 17.235222 19.641997 19.886519
## [223] 20.802253 17.381458 21.964981 18.893952 15.904972 18.648414
## [229] 66.166068 65.620985 67.072356 60.185602 62.413986 67.929049
## [235] 65.517518 60.961017 64.688061 69.931399 69.658579 70.328084
## [241] 60.989789 67.274525 64.799546 53.894054 63.146127 70.241969
## [247] 46.699514 51.516577 50.672650 52.609783 57.696899 51.664586
## [253] 47.504501 54.707421 53.200085 53.138815 54.388592 56.614428
## [259] 51.798356 40.253292 40.129096 35.099142 33.927823 51.325809
## [265] 36.152816 44.136957 36.490576 36.764993 40.157668 40.599202
## [271] 38.931438 38.332159 32.133048 41.120461 38.029023 25.357487
## [277] 34.691205 30.562750 26.724601 29.745590 35.677358 32.655220
## [283] 34.011909 31.111208 34.267874 33.581231 89.958728 90.469712
## [289] 87.105545 92.233615 86.431134 91.934977 87.185837 91.270344
## [295] 88.068187 79.500994 4.099071 11.338438 3.729256 3.678154
## [301] 3.900084 7.863293 5.181441 5.920663 7.151582 9.977018
## [307] 78.341921 84.395514 84.230651 84.245365 79.795880 76.024013
## [313] 81.137735 85.046935
```

```
tri3<- knn(train2, test2,cl=target_category1, k=3)
tri3
```

```
## [1] 43.7919258607276 49.0568067996152 47.3617314214868 48.4179268510554
## [5] 45.7167559254377 47.8767983129626 51.7751073869153 47.7375174242204
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## [13] 45.3804205874066 30.8177346493774 33.3019700349431 32.5650007292488
## [17] 37.1049363269521 35.1518367144068 34.2774280361879 33.5714390140576
## [21] 32.5488177764013 36.2245020104413 35.1474993929609 34.4195005866033
## [25] 34.6006006230431 33.5714390140576 32.5488177764013 34.0682358969689
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## [41] 77.2234705316198 73.0854224713187 74.2113381233801 75.601491767399
## [45] 89.6063432471092 99.8282758571575 91.7157390908268 98.0194483969556
## [49] 87.9944022852861 93.6495965598428 99.9443868455062 61.1737877213062
## [53] 55.7497998210834 54.9862479156366 55.6096639902608 58.6396880252212
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## [69] 45.0970637136275 46.060301908242 45.1083581670469 42.4308560256566
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## [73] 37.7540472401466 37.3700975918108 31.5198522705667 38.9426946535535
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## [97] 55.6955193126253 59.2666642348326 55.1593066314617 54.9460588553952
## [101] 56.3949708139461 55.1593066314617 54.5221530479789 58.5728225614085
## [105] 59.4460255283312 40.7935055110434 41.5709025128232 41.1067213818534
## [109] 41.0366179686135 40.7935055110434 42.2103682885159 41.8233338242915
## [113] 40.1568427411013 40.8235531590108 40.9873872480757 42.7082487058562
## [117] 41.9070373788573 35.3283654455313 35.4675970046594 33.2867998190026
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## [153] 66.1269739345061 71.688205647685 70.6830846690102 70.8569321417265
## [157] 73.1854893732835 73.1854893732835 65.3767182253813 56.1806898411819
## [161] 58.3269579473748 56.2282163153585 60.0896247916007 62.0422859569751
## [165] 58.3269579473748 54.5782281995556 58.3087409448668 55.7068940942384
## [169] 52.3068063824704 85.8130419197697 82.5104768024922 81.5359386917231
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## [177] 87.5159045761444 81.5178615711508 89.760253907714 83.1579838514005
## [181] 82.8316409407458 84.2176027145021 41.232996587068 35.7246706673687
## [185] 31.6097591346661 45.5045960242325 36.6510127607396 35.9239919146206
## [189] 39.8144391849576 17.0677130600271 15.2380144653792 15.2380144653792
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## [197] 13.8738307904596 15.474539801644 11.6382431695813 98.5099522776882
## [201] 100.026019655187 98.4913945928498 100.160366721865 99.975232206677
## [205] 99.4042576440317 98.1659170017009 96.933186126479 84.0648763202065
## [209] 88.6068026778963 91.9530367072208 84.6337283723229 88.3277991580817
## [213] 88.6499515381018 85.8167126519771 88.4147127382334 90.6957720676065
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tri5
```

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## [5] 45.7167559254377 47.3617314214868 51.7751073869153 47.3617314214868
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 ## [49] 87.1322284596602 93.4077074967855 99.5344825203521 60.2112196027841
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## 266 Levels: 100.010051949193 11.6382431695813 ... 99.975232206677
```

```
tri10<- knn(train2, test2,cl=target_category1, k=10)
tri10
```

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## [9] 45.5045960242325 48.6298105447762 44.76009073205 35.7246706673687
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## [220,]	477	377	589	862	605	297	826	962	470	864
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```

```
tri15<- knn(train2, test2,cl=target_category1, k=15)
tri15
```

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## [5] 44.76009073205 44.76009073205 47.9371056945732 44.7915826139299
## [9] 44.7915826139299 47.7375174242204 44.76009073205 35.7246706673687
## [13] 44.172495710781 30.8177346493774 30.8177346493774 31.9810590026424
## [17] 35.0847077372775 33.814723447555 33.8396266520846 32.5650007292488
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## [81] 17.2102030282721 13.4805759175033 16.1825075167228 11.8415243139411
## [85] 13.023017551076 15.3417791368495 13.023017551076 11.8415243139411
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## [101] 54.5843111474089 54.5221530479789 51.8149485528634 55.6646493705485
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##	[15,]	737	1162	345	600	1074	993	1190	1092	1037	243	17	1247	1042
##	[16,]	17	243	1236	993	1092	213	197	681	600	1042	1037	519	98
##	[17,]	641	518	469	583	1218	967	714	180	319	65	461	456	823
##	[18,]	1190	1074	345	493	838	1037	565	180	319	737	65	27	583
##	[19,]	1112	376	103	856	26	851	138	1122	1098	624	22	549	1124
##	[20,]	213	197	131	98	977	519	681	1203	624	111	1236	138	937
##	[21,]	600	1162	993	243	17	345	1037	1092	1074	737	1042	1236	1190
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##	[37,]	1015	755	925	443	306	351	899	618	782	682	865	1090	203
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##	[40,]	700	1115	575	897	328	309	13	1130	1189	909	1194	640	121
##	[41,]	1115	700	803	328	121	1103	575	897	309	1130	341	13	1189
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##	[43,]	1039	692	623	1232	261	1249	39	465	629	288	881	312	1194
##	[44,]	1150	934	804	235	629	640	299	13	1189	223	909	881	1130
##	[45,]	1125	114	693	497	611	449	1108	902	1048	468	313	400	999
##	[46,]	20	820	2	917	1136	541	1205	846	278	683	922	1225	757
##	[47,]	902	114	611	497	620	400	468	1193	595	449	750	313	88
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##	[49,]	693	807	237	953	586	117	779	1094	1048	1108	260	551	81
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##	[52,]	295	662	426	657	1217	976	80	358	992	812	1104	543	125
##	[53,]	991	75	230	53	107	208	1204	9	720	356	1186	1073	145
##	[54,]	711	1161	1206	245	53	1186	68	54	209	9	316	1070	255
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##	[65,]	913	310	529	32	472	406	269	938	964	82	323	775	765
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##	[77,]	99	357	685	741	877	297	171	826	605	470	377	477	651
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##	[79,]	819	788	139	450	1101	248	1219	651	366	196	740	857	171
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##	[86,]	1088	886	678	1019	1167	579	189	193	738	975	946	1082	771
##	[87,]	1220	833	450	944	1101	877	817	1067	741	357	651	171	99
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##	[90,]	63	470	826	297	605	1008	377	452	99	496	537	477	962
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##	[95,]	63	470	826	1008	297	605	452	537	496	377	962	589	99
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##	[97,]	48	939	528	1049	360	1230	747	598	688	365	86	785	163
##	[98,]	576	1157	320	58	281	163	463	626	130	688	1230	86	1004
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## [213,] 0.029815851 0.030461115 0.032927543
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## 229 Levels: 11.6382431695813 11.8415243139411 ... 98.7658216243529

```

```
tri20<- knn(train2, test2,cl=target_category1, k=20)
tri20
```

```
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##      [5] 43.7919258607276 44.0943496662554 47.7375174242204 44.76009073205
##      [9] 43.7919258607276 47.3617314214868 43.9046374599506 34.7045882693207
##     [13] 42.2630213246483 30.8177346493774 30.8177346493774 30.8177346493774
##     [17] 34.7776019878347 33.3019700349431 33.1836257275989 32.5650007292488
##     [21] 30.8177346493774 33.814723447555 33.6876946286903 33.5714390140576
##     [25] 33.5714390140576 32.5650007292488 30.8177346493774 32.5650007292488
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##     [33] 82.6742442375643 84.6337283723229 83.0795980766973 81.0625201784481
##     [37] 80.3575813232903 73.7554630776545 72.095528384837 75.2903321030857
##     [41] 75.8517192717127 71.4497881022867 72.5398440896319 74.6061559362642
##     [45] 87.5433392709512 94.3963426409762 89.3831691964022 93.0586565298844
##     [49] 84.8607474856322 90.7665350749989 93.4077074967855 59.5957141685594
##     [53] 53.2967516828685 53.4961352906188 54.3465308706129 57.1097809036802
##     [57] 49.9105455250393 57.6428115621762 59.5457431836181 57.1097809036802
##     [61] 49.9105455250393 46.2314937308097 57.7178384635905 54.5782281995556
##     [65] 43.4677596756233 42.5315878048052 45.1083581670469 43.2054339653476
##     [69] 43.2054339653476 43.660010563542 42.5315878048052 38.9426946535535
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##     [81] 16.3490498987844 11.6382431695813 14.0048329957069 11.8415243139411
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##     [89] 11.8415243139411 17.1458205452429 11.8415243139411 11.8415243139411
##     [93] 16.1825075167228 11.8415243139411 17.1458205452429 54.5221530479789
##     [97] 54.5221530479789 55.6646493705485 51.8149485528634 52.1355251798401
##    [101] 54.5843111474089 54.5221530479789 50.8843331014925 54.5221530479789
##    [105] 56.3645684274681 40.1568427411013 40.1568427411013 40.1568427411013
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##    [113] 40.1568427411013 40.1568427411013 39.1954139668857 40.1568427411013
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##    [121] 32.9749554781539 33.2815600126507 31.8717885646096 31.4910171419432
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##    [141] 65.7838234249149 65.7838234249149 65.7774382915149 67.2687062598749
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##    [153] 64.0850458438716 69.5798667466664 68.546032010062 66.8359855469976
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## [201] 97.7645407616702 95.7333763590829 97.554542874913 97.554542874913
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## [227,]	817	935	819	862	477	297	605
## [228,]	1046	1167	579	1155	291	771	292
## [229,]	494	1043	845	948	813	961	754
## [230,]	451	612	280	372	1069	1197	562
## [231,]	1223	842	949	1139	943	1171	697
## [232,]	748	1224	381	3	451	561	845
## [233,]	333	1111	280	432	505	612	521
## [234,]	280	1171	1069	1139	1223	952	3
## [235,]	748	561	505	494	562	90	521
## [236,]	504	842	280	949	408	146	90
## [237,]	90	333	3	1139	212	948	943
## [238,]	571	1081	280	1089	929	408	494
## [239,]	612	146	943	1171	697	1139	1111
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## [244,]	494	772	674	1171	943	280	985
## [245,]	612	1224	381	333	372	1043	754
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## [247,]	441	964	849	269	157	532	478
## [248,]	774	1250	10	441	644	1120	128

## [249,]	525	843	219	323	644	472	32
## [250,]	1080	792	532	157	699	25	560
## [251,]	282	991	438	563	774	1120	418
## [252,]	1116	157	563	1083	1080	532	128
## [253,]	1231	441	1250	843	775	157	882
## [254,]	774	759	572	936	219	89	438
## [255,]	532	128	418	1133	882	157	774
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## [260,]	493	65	512	565	641	180	518
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## [262,]	890	1068	1122	138	624	823	549
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## [265,]	1042	600	518	714	716	1162	243
## [266,]	105	194	1096	890	987	650	1218
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## [304,]   1227   1165    120    696    422   1054    647
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## [309,]    670    960   1210    336   1078    164    577
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## [293,] 0.028664156 0.030260649 0.030714224 0.03276365 0.03297954 0.03399780
## [294,] 0.027401817 0.028287322 0.028761211 0.02972132 0.03046736 0.03074389
## [295,] 0.019658668 0.019947297 0.021416433 0.02191406 0.02464066 0.02528965
## [296,] 0.068108019 0.069362837 0.069474163 0.07134903 0.07420565 0.07427456
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## [298,] 0.037370847 0.039512230 0.041115162 0.04198900 0.04452288 0.04605664
## [299,] 0.026329111 0.027501594 0.027747951 0.02840189 0.02907913 0.03468117
## [300,] 0.030542225 0.030629798 0.031345927 0.03313262 0.03440546 0.03458719
## [301,] 0.028165005 0.028271019 0.028963828 0.03102155 0.03202701 0.03286926
## [302,] 0.021903829 0.022531624 0.022700563 0.02326711 0.02438209 0.02699420
## [303,] 0.028215964 0.029105950 0.029602829 0.03040517 0.03104108 0.03161858
## [304,] 0.033823837 0.033979852 0.034704387 0.03504934 0.03539116 0.03581754
## [305,] 0.016460047 0.017078722 0.018225997 0.02000370 0.02062992 0.02202184
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## [307,] 0.031930728 0.032173302 0.032953407 0.03386234 0.03512650 0.03708359
## [308,] 0.036982003 0.038939633 0.039064992 0.03955530 0.03997435 0.04208358
## [309,] 0.051066458 0.051345729 0.054430650 0.05481602 0.05526696 0.05625016
## [310,] 0.030178897 0.032103567 0.033877204 0.03520284 0.03572816 0.03887896
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## [313,] 0.025777293 0.028764271 0.029095128 0.03335770 0.03958845 0.04040862
## [314,] 0.047831914 0.048227838 0.048912690 0.04950741 0.05211555 0.05402224
##      [,19]      [,20]
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## [2,] 0.04641142 0.04791028
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## [4,] 0.03780903 0.03820441
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## [6,] 0.03353725 0.03532183
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## [8,] 0.03853936 0.03908236
## [9,] 0.03792765 0.03887168
## [10,] 0.03994071 0.04194941
## [11,] 0.03538918 0.03552869
## [12,] 0.03198231 0.03204150
## [13,] 0.05392880 0.05405419

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## [14,] 0.03943824 0.04007745
## [15,] 0.04509961 0.04558740
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## [17,] 0.02313922 0.02319514
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## [36,] 0.02347159 0.02925314
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## [284,] 0.07425500 0.07608662
## [285,] 0.03871250 0.04032049
## [286,] 0.09330383 0.09446572
## [287,] 0.02844501 0.03023787
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## [301,] 0.03368854 0.03504613
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## [303,] 0.03278674 0.03326276
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## [314,] 0.05449672 0.05486630
## 206 Levels: 11.6382431695813 11.8415243139411 ... 97.7645407616702
```

```
tri25<- knn(train2, test2,cl=target_category1, k=25)
tri25
```

```
## [1] 41.232996587068 44.7915826139299 42.8364919125624 45.0328759122301
## [5] 42.7377608444448 43.7919258607276 47.7375174242204 43.7919258607276
## [9] 43.7919258607276 45.5045960242325 43.660010563542 33.7693051352592
## [13] 41.8896917292361 30.8177346493774 30.8177346493774 30.8177346493774
## [17] 34.4839370565386 33.3019700349431 33.1836257275989 32.5650007292488
## [21] 30.8177346493774 33.3019700349431 33.3032778415094 33.5714390140576
## [25] 33.5714390140576 32.5650007292488 30.8177346493774 32.5488177764013
## [29] 33.3019700349431 33.5714390140576 33.1836257275989 90.418433480603
## [33] 82.6742442375643 84.6337283723229 82.6742442375643 80.3575813232903
## [37] 72.2993786273707 73.7554630776545 72.095528384837 74.7412245763958
## [41] 75.2903321030857 71.1222218389244 72.5398440896319 73.8867257269488
## [45] 87.1322284596602 93.0586565298844 87.5433392709512 92.3728569712435
## [49] 84.681354806255 89.3831691964022 93.4077074967855 58.6396880252212
## [53] 53.2967516828685 53.4961352906188 54.3465308706129 57.0763842325212
## [57] 48.6145888169703 57.6428115621762 59.2439042629941 57.0763842325212
## [61] 49.9105455250393 45.778240374191 57.7178384635905 54.5782281995556
## [65] 43.4677596756233 42.5315878048052 45.1083581670469 42.5315878048052
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```

```

## [73] 35.7982476072395 32.9165904997253 30.8389234754042 34.0765937093431
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## [81] 16.2161167670548 11.6382431695813 13.978497180078 11.8415243139411
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## [89] 11.8415243139411 16.2161167670548 11.8415243139411 11.8415243139411
## [93] 14.4958047486367 11.8415243139411 17.1458205452429 54.5221530479789
## [97] 52.1663782464574 55.6310604307694 46.4750588230673 51.8149485528634
## [101] 52.1355251798401 54.5221530479789 50.8843331014925 54.5221530479789
## [105] 56.1490282018942 40.1568427411013 40.1568427411013 40.1568427411013
## [109] 40.1568427411013 40.1568427411013 40.1568427411013 37.5862620225026
## [113] 40.1568427411013 40.1568427411013 39.1954139668857 40.1568427411013
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## [129] 31.4910171419432 32.2554013265108 32.2554013265108 37.5862620225026
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## [201,]	1026	979	30	655	918	573	215	386	489	259	272	11	56
## [202,]	51	399	149	535	215	272	573	918	30	361	655	259	979
## [203,]	311	520	825	56	11	1024	1034	591	386	593	110	347	1035
## [204,]	338	825	1035	311	520	252	56	1034	11	110	593	1024	591
## [205,]	1024	11	520	56	591	311	347	1034	489	386	979	1026	655
## [206,]	252	1035	110	593	1034	338	454	520	311	540	591	825	347
## [207,]	399	361	149	51	942	259	215	489	70	655	918	573	979

##	[208,]	1027	1240	687	93	1061	217	524	81	168	407	260	1025	638
##	[209,]	190	673	102	554	79	43	1084	185	93	746	33	821	508
##	[210,]	920	809	1242	1237	150	391	781	350	182	818	1212	836	246
##	[211,]	703	459	168	806	1134	407	1025	524	117	779	866	1090	865
##	[212,]	586	807	693	237	1094	551	953	490	912	779	260	117	746
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##	[218,]	1237	1084	920	632	43	980	809	102	150	1242	836	821	190
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##	[248,]	1050	882	467	219	25	1080	157	532	792	1208	883	1083	418
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##	[3,]	721	371	523	1071	1017	1151	1172	374	653	637	1057	162
##	[4,]	654	523	1038	607	45	268	578	767	337	1071	285	371
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##	[6,]	371	721	415	1151	653	1071	1017	374	162	1172	419	767
##	[7,]	764	751	1164	1051	679	64	694	162	1033	1143	653	316
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##	[10,]	387	64	653	162	1071	457	331	316	751	136	607	285
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##	[12,]	140	1072	60	1055	585	1056	805	276	889	552	384	78
##	[13,]	1164	419	415	1053	607	728	764	1143	613	778	1017	637
##	[14,]	977	519	1042	937	1037	1203	624	138	111	549	967	1074
##	[15,]	838	319	1236	493	681	565	180	583	65	937	716	519
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##	[26,]	519	549	26	681	17	937	1122	1112	456	243	461	967
##	[27,]	1042	681	319	197	937	213	519	98	838	977	583	967
##	[28,]	1236	131	1203	549	624	319	461	138	456	583	993	600
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##	[32,]	983	963	981	1086	921	1147	486	841	933	594	1188	816
##	[33,]	459	787	210	306	449	806	117	779	703	865	237	1090
##	[34,]	524	586	953	508	1094	33	168	185	490	1027	93	703
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```

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C. In later lessons, you will learn about linear classifiers. These algorithms work by defining a decision boundary that separates the different categories.

Looking back at the plots of the data, do you think a linear classifier would work well on these datasets?

I believe that linear classifiers would work for both the binary and trinary plots.

Looking at the data plotted it shows that there would be success using the linear classifiers.

Through my understanding these plots would work with a linear type model.